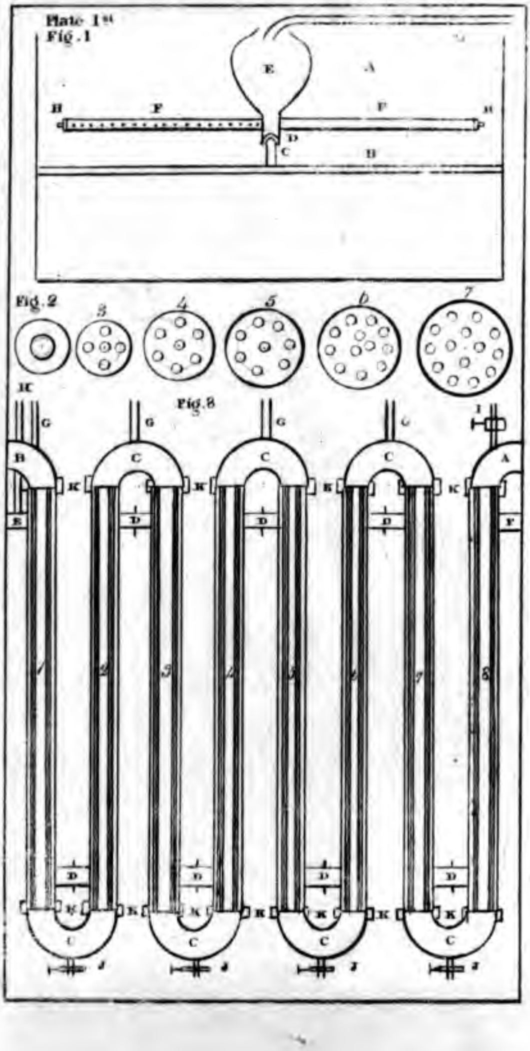


Plate 1st
Fig. 1
Fig. 2
Fig. 8

A THEORETICAL AND PRACTICAL

TREATISE

ON

MALTING AND BREWING.

By GEORGE ADOLPHUS WIGNEY,

Brewer,

OF BRIGHTON, SUSSEX.

"To copy Nature,
Nature's laws must be obeyed."

SECOND EDITION, IMPROVED.

BRIGHTON:

PRINTED FOR THE AUTHOR, BY PHILLIPS AND CO.,
POPLAR PLACE.

1835.

PREFACE.

It is said. that superficial readers seldom read a Preface or Introduction, so anxious are they to get at the body of the work. They wish to taste the marrow without the trouble of breaking the bone.

But all authors have a motive for writing a Preface, —and so have I! Mine is principally to recommend the reader to peruse most attentively the Introduction, because it contains a small portion of that information which he should be possessed of, before he can understand and duly appreciate the merit or demerit of the work itself; because that little may awaken a desire to obtain a better and more ample supply from other and more copious sources, and because, without the possession of which, and much more, neither maltster or brewer, I conceive, can properly understand, or prove competent to conduct his business to the best advantage.

"There is no royal road to learning." The reader may suppose that I am both willing and able to show him a short and easy way to a perfect system of malting and brewing; but if he does, he will find himself much mistaken. Willing I should be, if I was but able! But never having yet found the person or the book from which I could discover it myself, it would be highly presumptuous and disingenuous in me to assume a capability not pretended to by others, and which I

conceive to be impossible for any one to perform. I aim at nothing more than to furnish, in as clear, explicit, and unreserved terms as I can, all the experience which I have been able to obtain on these subjects, during twenty years' assiduous and unremitting research and enquiry, in every Treatise written expressly or indirectly upon them, which I have been able to obtain or hear of; such as Works on Malting and Brewing, Distillation and Chemistry; and to which have added (what I conceive to be) much valuable information, both theoretical and practical, which is not to be found in any work that I have ever yet met with, and which are the results of personal observations, experiments, and discoveries.

At about twenty-six years of age, without any previous knowledge of the business, I received a month's instructions in brewing, for a premium, from a person who passed current as a good practical brewer, and thought myself a very clever fellow, beeause, on the first occasion after he left me to act for myself, I brewed a guile of ale, the product of which cost me three halfpence per gallon less than the cost of such as my instructor had brewed for me. But a few difficulties promptly met with very soon brought me to my senses, aud enabled me to discover, that I had learnt much error, and but little truth; and have since been twenty years eradicating the prejudices inculcated in one month; in unlearning a bad system, and gradually grafting upon it a better; induced and urged on by the best of all instructors, "necessity."

I should not have thus much adverted to myself, but for the purpose of furnishing an example of the circumstances under which too many commence the brewing business, both at an earlier and later age than at which I began, without any previous suitable chemical education; taught by a person himself no

better taught; instructed to pursue a practical system such as he had learnt, without rule or explanation to reveal the why and wherefore; a mere blind teacher of the blind; a stranger to causes, and ignorant of many important effects; a detester of theory, and an admirer of only one practical system, and that one his own.

Both malting and brewing are chemical operations, and to attain to proficiency in the art, an extensive knowledge of theoretical chemistry, and a slight portion of practical, is necessary. Well grounded in such science, the practitioner becomes acquainted with the laws of Nature, studies her admirable process in germination, vegetation, and fermentation, and takes her as his pattern and guide, and endeavours to imitate her as closely as he possibly can, in the several assimilating operations he is required to perform. He knows her seasons, and adopts them as his own, as well as circumstances admit; and when compelled to take an inauspicious period for the accomplishment of any operation, he views the dangers, ascertains the difficulties, and by the aid of art accommodates his practice to the occasion, endeavouring thereby to realise the results that he might calculate upon in a more propitious season.

Although the author is fully aware what are the requisite attainments, yet he is perfectly conscious that he does not possess them to a desirable extent, or sufficient to render him a competent instructor of others; yet such as he is, he presumes to offer to those who have made less progress than himself in the path of improvement, such information as he has gleaned, which he frankly tells them, they will find fall short of their need, if not of their expectations.

The information which maltsters and brewers really need, and which they may imagine they need, are

heat of the mashing menstruum for the first mash, under every circumstance, with elaborate tables for use.

An improved system of obtaining the extract from malt, combining superiority in quality, with increase in quantity, the obtainment in a shorter period, and at less cost than usual. A cheap and efficacious method of preserving dry hops, serviceable suggestions as to their use, and mode of recovering the malt extract adhering to boiled hops. Description of a refrigerator, (with plate, &c.), invented by the Author, very economical and efficacious in use, and of small cost. Important information relative to the use of yeast, the means of separating the beer from it, the mode of rendering such beer serviceable, the product from a given quantity of yeast furnished. A clear and consecutive exposition of the theory of fermentation, with full instructions relative to practice on right principles. A full description of a mode of fermentation in the cask, invented by the Author, on the self-filling-up principle, an improvement upon the methods usually practised, avoiding the chemical consequences, from a defect in their arrangements, and ensuring right results on more economical and simple principles. Means by which large quantities of stale beer may be got rid of, without injury, by those who have a stock on hand; and how to avoid an accumulation of a stock for the future. General instructions relative to racking and sending out. Much valuable information under the head of Store beer. Full instructions relative to the brewing of porter, of the first-rate quality, and standing high in public estimation. Desirable information relative to table beer. An ample description of an expeditious and economical system of brewing, with plate, references, &c. the invention of the Author, with full details of the process, proving the capability of brewing, with ease, from four quarters of malt up to

thirty, in the short space of from 6 to 8 hours; or double brewings from ten and a half to fourteen hours and a half by which, quality and quantity of produce is improved and ensured, with economy and saving in the obtainment. Details of the old and new system of brewing are also furnished in juxta position, showing the several points of difference between the two, and the advantages in favor of the new, without the sacrifice of one benefit secured by the old method. The whole of the mechanical arrangements made with due regard to chemical consequences, and the greatest simplicity, combined with the utmost economy, reducing labour, wear and tear, and cost of fuel. The fittings up of any premises will admit of alterations suitable for the purpose; and the cost of a new brewery, and the fittings up on such a plan, are considerably below the cost of building and fitting up on usual principles. Descriptive particulars of a four quarter brewery, standing on ground measuring twenty-two feet by fourteen, comprising all that is needful for the business, built and fitted up on such principles about four years since, the total cost of which was under £500, and in which the parties have brewed from four to twelve quarters of malt, ever since its erection. A superior method of seasoning new, and purifying old, and unsweet casks and utensils.

The proceeds of four years' brewings (1831-2-3, and 4) for ale only, from barley malt (not any chevalier) of the growth of the southern and western counties, as per following statement, should have been furnished in such form also, in the body of the work, but was omitted for want of thought. They will serve to show the value of the system of brewing recommended, as relates to quantity of produce; and as regards quality, I can merely state, that I have found the improvement in the latter department not less than in the former;

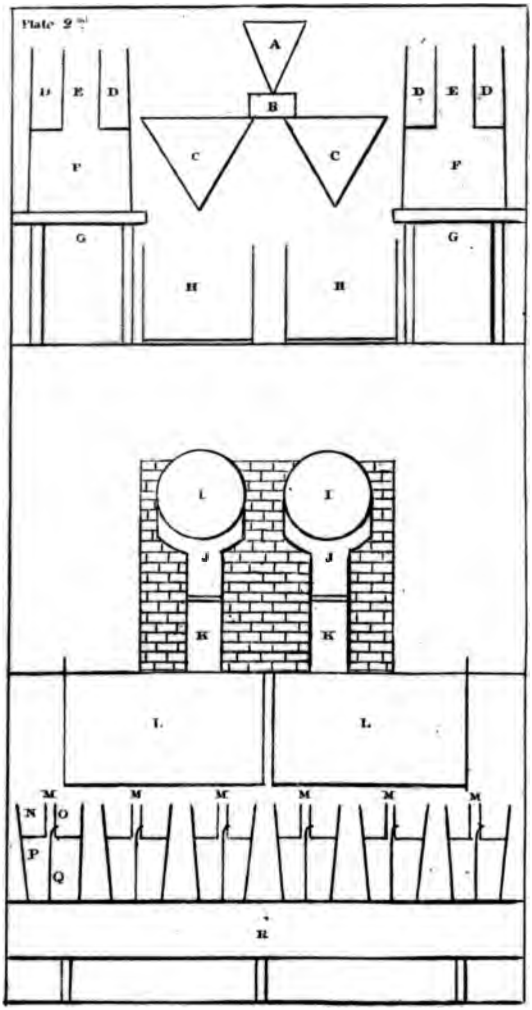
and in proof of the correctness of which, can furnish ample reference and testimony, if required.

Statement, exhibiting the produce of barley malt, in boiled wort, as per tun guage, ascertained by saccharometer (Dring and Fage's, Long's, or Swan's) at the time of pitching.

Quantity malt brewed. Quarters.		Produce per qr. of boiled wort. lbs.		lbs.	
52	produced from	72	to	73	per quarter.
10	do.	73	to	74	do.
64	do.	74	to	75	do.
76	do.	75	to	76	do.
147	do.	76	to	77	do.
241	do.	77	to	78	do.
78	do.	78	to	79	do.
142	do.	79	to	80	do.
265	do.	80	to	81	do.
341	do.	81	to	82	do.
408	do.	82	to	83	do.
475	do.	83	to	84	do.
336	do.	84	to	85	do.
530	do.	85	to	86	do.
565	do.	86	to	87	do.
845	do.	87	to	88	do.
532	do.	88	to	89	do.
444	do.	89	to	90	do.
242	do.	90	to	91	do.
200	do.	91	to	92	do.
26	do.	92	to	93	do.
52	do.	93	to	94	do.
30	do.	94	to	95	do.
20	do.	98	to	99	do.
20	do.	99	to	100	do.
6141					

The great difference in the quantity of extract obtained, as shown by the annexed statement, is not only to be attributed to a great difference in the quality of the malt brewed, but also to the circumstance of a great portion being the produce of brewings to which a return wort had been carried over from a previous brewing, and (as is ever the case) a considerable

portion of the extract contained in such return wort is coagulated by boiling in the state of admixture with the worts of the second brewing, and such return wort being placed to the credit of the first brewing, and to the debit of the second, renders the produce of the second apparently less, and the first more than it really is. In the body of the work this subject is fully discussed, and the average produce of each year furnished; and also the produce of white and brown wheat malt, the proper method of manufacturing and brewing of which, promises, from the state of the ingathering crops, and the probable relative prices and quality of wheat and barley, the coming season; to render every attainable information valuable, in proportion to the extent of a brewer's consumption; and the author is well convinced, that those who do not possess any, or a competent knowlege and experience, of the proper method to malt wheat, and afterwards to brew it on right principles, and who know not the relative value and produce of each species, will find, in this volume, such information relative thereto, as will alone be sufficient to compensate for its cost, provided his consumption of malt is to a moderate extent.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INTRODUCTION.

ULTIMATE PRINCIPLES.

All known substances are in a state denominated either as solid, fluid, or gaseous.

In either state they are compounds of an aggregate assemblage of particles, cohering together, subject to the power and limitation of (what are called) the laws of Nature.

The division of such particles into classes is not, perhaps, yet completed; but the division with which we are best acquainted, (and which may be sufficient for the purpose of this work), is as follows:—Caloric (heat), Light, Oxygen, Nitrogen, Hydrogen, and Carbon.

The particles of which all substances are composed, are called "ultimate principles."

Particles possessing distinct and separate properties, may be found to exist in an unmixed state, in some of the gases; but in solids and fluids, never.

All solids and fluids, and many of the gases, are compounds of particles, possessing different properties.

The purport of the classification is to designate their respective properties.

All solids and fluids are reducible, by the aid of Caloric, into gases.

By such a reduction, the properties and quantities of ultimate principles, of which solids and fluids and some of the gases are composed, may be ascertained: and such process is termed Analytical.

Compound gases may be resolved into simple gases, and the properties and quantities of the ultimate principles, which constitute the compound, may be ascertained.

The properties and quantities of the ultimate principles, of which some bodies are composed, having been ascertained by analysis; similar bodies may be formed by the union of a proper proportion of proper gases; either a compound gas, a fluid, or a solid. The first, by an admixture of simple gases; the two latter, by such an admixture; and a subsequent abstraction of Caloric, in the ratio needed, to constitute either the fluid or solid: and such a process is termed Synthetical.

The forms and sizes of particles, denominated ultimate principles, are unknown. They may be Spherical: they may differ in size: the case must be conjectural: the hypothesis which I have framed for myself is, that they are Spherical; that they differ in size; and that the particles of Caloric and Light are infinitely smaller than the particles of Oxygen, Nitrogen, Hydrogen, and Carbon.

THE LAWS TO WHICH ULTIMATE PRINCIPLES ARE SUBJECT.

Simple Attraction.—The power which causes two particles at a distance from each other, to leave their places, and unite themselves to each other.

Attraction of Aggregation.—The power by which such two particles, when united together, attract other particles to themselves, they remaining immoveable, and causing single particles to leave their places, and unite themselves to them.

Attraction of Cohesion —The power by which two or more particles, which have been united by simple or aggregate attraction, until separated by a superior power.

Separation.—The power by which two or more particles, which have been united by simple or aggregate attraction, and which remain united by attraction of cohesion, are again disunited.

Equalization.—The law to which Caloric is subject, and by which it effects combustion in such bodies as are partially or totally destroyed or changed by heat. By this Law, if one body possesses more Caloric than another in its vicinity, a transition from that which possesses most, to that which possesses least, will occur, until the quantity in each becomes equal. This transition, from the former to the latter, may be sufficient to overpower the attraction of cohesion, by which the ultimate principles, of which that body is composed, cohere together. The quantity transfered may be sufficient to destroy the attraction of cohesion, which, previous to the transfer, caused the solidity of that body, and thereby the solid may be converted into a fluid, or gas, or vapour: and the transfer may be equal to the overpowering of attraction of aggregation, and simple attraction.

Illustration.—Ice is a solid; because the ultimate principles of which it is composed, cohere together, being subject to the power of attraction of cohesion. Convert it into water by the impartation of Caloric, and you thereby overcome the power of attraction of cohesion, and have converted the solid into a fluid by the addition of particles of Caloric, which have separated the ultimate principles one from the other; and as attraction of cohesion does not exist between the particles of Caloric, and the ultimate principles of which bodies are composed, fluidity is in this case the consequence; and for the sake of clear illustration, the particles of Caloric may be compared to so many friction rollers, by which the ultimate principles are enabled to move freely among themselves, and thereby Caloric

confers the property of fluidity. Continue the impartation, and the ultimate principles are still further separated, and the process may be continued until steam is the product; yet aggregate and simple attraction is not overcome, while as steam it continues. Reverse the process, and abstract Caloric from steam, and you convert it into water, and this process is called Condensation. Continue the abstraction, and you may convert the water into ice; the fluid into a solid. Place ice in a vessel over fuel in a state of combustion, and the Caloric, converted from a state of latency into activity by the decomposition of that fuel, will pass through the interstices presented by the ultimate principles, cohering together, of which the vessel is composed; and enter into the interstices presented by the ultimate principles, cohering together, of which the ice is composed. Such transition of Caloric from the fuel to the ice, is induced by the law of equalization. Before this ice is melted, to every pound of it, particles of Caloric, sufficient to raise the mercury in a thermometer 140 degrees, must pass from the burning fuel to the ice; and it will then be found that this ice, which by the thermometer indicated a temperature of 32 degrees previous to the impartation of Caloric, still indicates 32 degrees the moment it has been all converted into water; and the reason is, because the 140 degrees of free Caloric, which has been imparted to every pound of it, has, upon its entrance into the ice, become latent. Such quantity of Caloric, is denominated the Caloric of Fluidity. A continuation of the transition may occur, until vapour or steam arises from the upper surface of the water; the temperature of which, under the ordinary pressure of the Atmosphere, is 212 degrees: and vapour, at this temperature, may leave the body of water long before the temperature of the whole body is equal to it; because the particles of Caloric which permeate the bottom of

the vessel, ascend through the body of the water, until they reach the upper surface, and thereby the temperature of the upper surface attains to 212 degrees, before the lower strata, and unless the impartation of Caloric to the whole body of water, is more rapid than its escape from its surface; the whole body of water may be converted into vapour, or steam, and the remaining bulk never indicate the temperature of 212 degrees. Water is said to evaporate by boiling, when the temperature of the whole bulk is at 212 degrees and it is in a state of ebullition. And it is said to evaporate by simmering, when the temperature of the whole bulk is at any point below 212 degrees, and steam leaves its upper surface.

Gravitation.—The power by which all bodies, and the ultimate principles of which all bodies are composed, have a tendency to fall towards the centre of the earth, counteracted and opposed only by the law of equalization, to which Caloric is subject. The effect of gravitation is, to cause all bodies to fall towards the centre of the earth, with a force and celerity proportionate to their specific gravity. The effect of equalization to which Caloric is subject, is to enable an additional quantity of Caloric to enter a body, and thereby decrease the specific gravity of that body, provided the additional quantity of Caloric which enters, is sufficient to separate all or any part of the ultimate principles of which it is composed, one from the other. For as Caloric is not ponderable, however great the quantity imparted to a body, the statical weight of such body is not increased thereby. And if the impartation of Caloric is sufficient to separate the ultimate principles, of which such body is composed, one from the other, then such ultimate principles must necessarily occupy more space in the fluid medium in which such body exists. And as the impartation of Caloric to a body may

be continued, until such body by expansion, (the consequence of such impartation,) is so far increased in bulk, as to become specifically lighter than the same bulk of the fluid medium in which it exists; it will therefore rise in such fluid medium, until the specific gravity of both are equal, or until the body floats on the upper surface of that medium, if the medium is of greater specific gravity than the body. On this principle, therefore, it may be said, that equalization, to which Caloric is subject, counteracts and opposes gravitation.

ILLUSTRATION.—Water, by the power of gravitation, descends towards the centre of the earth, and is only prevented from reaching it, by its inability to percolate a variety of intervening substances. Water being in close contact, or within a short distance of any body possessing a large quantity of Caloric, in a state of freedom; by the law of equalization, as much Caloric will pass from that body to the water, as will render both of an equal temperature, provided the quantity, existing in the body, is not more than sufficient to raise the temperature of any portion of such water above 212 degrees. But if the quantity of Caloric, contained in that body, is more than sufficient to raise any part or the whole of that water to 212 degrees; then a portion, or the whole of such water, will be converted into steam. This conversion of water into steam, consists in separating the ultimate principles of which the water is composed, by the impartation of particles of Caloric, sufficiently far apart, as to render the ultimate principles, and particles of Caloric, collectively, lighter than an equal bulk of Atmospheric air, which they have displaced. Such being the case, it rises in that Atmospheric air, by which it is surrounded, and continues to ascend, until it reaches a point where the specific gravity of both are equal. Thus, therefore, this water, which, by the power of gravitation, had a tendency to

fall toward the centre of the earth; is caused by the power of equalization, to which Caloric is subject, to ascend and recede from its centre.

But the same law of equalization, to which Caloric is subject, and which has caused water, in the form of steam, to recede from the centre of the earth; operates again to cause its descent towards it. For in the ascent of steam in Atmospheric air, the Caloric, which enabled it to ascend, is soon abstracted by that air; the Caloric, in obedience to the law of equalization, quitting the steam to pass into the surrounding air. By this process, the ultimate principles are enabled to obey the law of attraction of aggregation, and unite together in separate aggregate quantities called drops, flakes, or crystallic solids, and descend by the power of gravitation towards the centre of the earth, as rain snow, or hail.

SOLIDS, FLUIDS, AND GASES OR VAPOURS.

All known substances may be divided into three Classes:—Solids, Fluids, and Gases or Vapours.

A solid is a substance composed of an assemblage of spherical particles, called ultimate principles, united together by simple and aggregate attraction; and remaining united by attraction of cohesion.

To constitute and continue a body solid, it is necessary that such particles should touch each other. A number of spherical particles touching each other, must necessarily present a number of interstices. The particles of Caloric and light being also spherical, but much smaller than the particles called ultimate principles, are able, and do enter, by the law of equalization and affinity, into the interstices presented by the union of the ultimate principles, of which the body is composed. Now if no more particles of Caloric enter into these

interstices than is sufficient to partly or quite fill them, then such body will remain solid, because the ultimate principles of which it is composed touch each other; and adhere together by attraction of cohesion.

A fluid may be composed of precisely the same ultimate principles as a solid. Indeed! to convert some solids into fluids; nothing more is necessary than to impart to such solids a sufficient number of particles of Caloric, as will more than fill the interstices. If this is done, the attraction of cohesion, which held united the ultimate principles, must yield to the superior separating force of the Caloric, compelled to enter by the law of equalization. Attraction of cohesion, being by this means paralyzed, or held in subjection; the particles, (called ultimate principles) are enabled to move freely among the particles of Caloric, as attraction of cohesion does not subsist between the particles of Caloric, and the particles, called ultimate principles.

It is this freedom of motion of the particles, which constitute a body, which gives to it properties, whereby we distinguish it from a solid, and denominate it a fluid.

A gas or vapour may also be composed of precisely the same ultimate principles as a solid or fluid. A solid may first be converted into a fluid, by the impartation of a sufficient quantity of Caloric, and subsequently into a gas or vapour, by the impartation of an additional quantity of Caloric. Or a solid may be converted into a gas or vapour, without the intervening process of converting the solid into a liquid. But in either case, the impartation of Caloric is necessary for the purpose. The distinguishing properties of a gas or vapour, are less specific gravity, and greater elasticity than a fluid or solid.

THE LAWS TO WHICH SOLIDS, FLUIDS, AND GASES ARE SUBJECT.

Affinity and Combustion.—By the Law of affinity, bodies are formed and destroyed.

By the law of affinity, ultimate principles unite; and by accretion, become bodies.

One body may be surrounded by other bodies, and the affinity existing between the ultimate principles of which such body is composed, and the ultimate principles of which the surrounding bodies are composed, may cause the ultimate principles, of which the single body is composed, to disunite themselves from the single body, and unite themselves to the other bodies, and continue so to do, until the single body is quite destroyed. By the law of combustion, bodies are formed and destroyed.

The decomposition of a body by combustion or otherwise, is but the separation of the ultimate principles, of which such body is composed, one from the other. And as such ultimate principles are indestructible, they must necessarily after such separation, become the component parts of other bodies.

The term combustion, as applied to the destruction of bodies, is by some used in a general sense, and by others in a single; for perspicuity, I would apply it in the single.

By the term combustion, may be understood the destruction of a body, by the impartation of Caloric; such impartation causing the ultimate principles, of which a body is composed, to separate sufficiently far from each other, as to place them beyond the precincts of simple attraction; the result being—the destruction of that body.

By affinity and combustion, bodies may not always be destroyed altogether, but partially.

By affinity or combustion, a body may not be partially

destroyed, but merely changed in its characteristics and properties.

The total or partial destruction, or change in the characteristics and properties of bodies, may be attributed to the power of equalization to which Caloric is subject. Such an effect may result from the operations of nature, or the work of man, by the agency of natural means.

CALORIC OR HEAT.

Caloric prevades all bodies; as a constituent principle in bodies, it exists in a latent state; as a non-constituent principle, it exists in them in an active state.

Its particles are supposed to be infinitely small, and much smaller than the ultimate principles, called Oxygen, Hydrogen, Nitrogen, and Carbon, and sufficiently so, as to be able to pass into and through the interstices presented by the union of the ultimate principles, without displacing them. But a separation will occur, when Caloric enters a body more rapidly than it can leave it, and in quantity sufficient to overcome the attraction of Cohesion.

It is supposed to proceed originally from the Sun, which by some is considered to be a body of fire; by others, an habitable globe, surrounded by a phosphorescent atmosphere, imparting heat and light. Caloric is supposed to move at the rate of 200,000 miles in a second of time.

Latent and active Caloric are arbitrary terms, given to express one and the same principle, occasionally existing in either state. Latent, when undisturbed, and existing in a body as a constituent principle, and which can only be separated from it, by the partial or total destruction of such body; and active, when disturbed by combustion partially or totally destroying the body in

which it existed as a component principle, and thereby setting it at liberty.

Caloric being subject to the law of equalization, is ever in a state of motion, or liable thereto.

By the law of equalization, may be understood the power by which Caloric will pass from one body, which possesses most, to another body, which possesses least Caloric in an active state, until both bodies possess an equal quantity of active Caloric. Some bodies possess more latent Caloric than other bodies, as a necessary constituent of the compound, in its natural state; such latent Caloric is not subject to the law of equalization, until all the active Caloric, which such body may possess, is first abstracted. Thus we may say, that all bodies possess a necessary and natural quantity of resident Caloric, not subject to abstraction, until the superfluous quantity, which such bodies may possess, is first abstracted.

The resident quantity is termed latent; the superfluous quantity, active.

Take water at any temperature, (say 50 degrees), and abstract the active Caloric until its temperature is reduced to 32 degrees; 18 degrees will then represent the quantity of active Caloric, of which such body has been deprived. If no further abstraction takes place, it will remain water. But to convert it into ice, it is necessary to continue the abstraction of latent Caloric, until 140 degrees are withdrawn, and then congelation will take place.

Ice, Hail, Snow, Water, and Steam, are composed of the same ultimate principles, combined with different portions of Caloric.

Water in a state of fluidity, and which possesses only 32 degrees of thermometric heat, or active Caloric, possesses also 140 degrees of latent heat, and which it must lose before it can be converted into (a solid) ice, which

is exemplified by taking an equal weight of ice and water, the latter at 172 degrees of heat, and putting them together, it will be found that the (solid) ice, is converted into (liquid) water; and that the temperature of the mixture is but 32 degrees: hence 140 of the 172 degrees of heat which the water possessed, has, agreeable to the law of equalization, departed from the (fluid) water, to the (solid) ice.

The impartation of Caloric, to an extent sufficient to over-power attraction of cohesion, will cause the expansion of all bodies, whether solid or fluid.

Æriform fluids are more expansive than fluids, and fluids more than solids.

By the expansion of bodies, we are to understand that an increase in their bulk has taken place, and that they occupy more space than they did previous to expansion.

The rise of the Mercury in the tube of a thermometer, is owing to the impartation of Caloric, and in proportion to the quantity received by the mercury, so is its expansion, and consequent rise; and in proportion to the quantity of Caloric abstracted, so is its contraction and consequent fall.

To comprehend the mode, by which the impartation of Caloric to the Mercury in the glass tube of a thermometer is effected:—it is necessary to imagine, that the glass tube is composed of spherical particles, united together by attraction of aggregation, and remaining so by attraction of cohesion. The particles so united, present interstices, and the particles of Caloric being smaller than the interstices, they are capable of passing through and into the interstices presented by the spherical particles of which the mercury is composed. With this view of the case, let us suppose that a thermometer is plunged into hot water, the effect will be, that as the water possesses more Caloric than the Mer-

cury (and such Caloric being subject to the law of equalization) a sufficient quantity will leave the water, pass through the interstices presented by the glass tube, enter into the mercury, and continue so to do, until the water and the mercury possess an equal quantity. Now the obvious effect of such impartation of Caloric to the Mercury, is to increase its bulk, and as the glass tube prevents the expansion of the mercury in a lateral direction, it must necessarily rise upward, in the vacuum, purposely created. The obvious effect also upon the water, by an abstraction of a portion of its Caloric, by the means of the thermometer, is to diminish the bulk of the water, which diminution is called contraction.

The weight of no substance is increased, by its combination with Caloric.

All the gases are compounded of the same ultimate principles as fluids and solids, but combined with a much larger quantity of Caloric.

All substances receive Caloric from other substances with which they come in contact, or are deprived of it by other substances; that which contains least, receiving from that which contains most; such passage of Caloric from one substance to another, continuing, until both substances possess an equal quantity.

Both fluids and solids are conductors of Caloric; fluids more capable than solids; and there is a great difference of conductive power among different fluids and solids.

Bodies which are incombustible at moderate temperatures, receive and part with Caloric, without undergoing total or partial decomposition. But combustible bodies, at moderate temperatures, are totally or partially decomposed, in proportion to the quantity of Caloric received.

Latent heat becomes active in all the cases of condensation of solids, liquids, and gases. In the case of the condensation of metals, by hammering, &c. Of

liquids, by an admixture of two or more, possessing different properties, such as spirits and water, &c. Of atmospheric air, in charging the air gun, &c.

Caloric, of itself, imparts neither benefit or injury to any substance, as a principle, but rather as an agent.

The mode in which Caloric acts, as an agent, in altering the properties of bodies, is, by its overpowering the attraction of cohesion and aggregation, which subsist among the ultimate principles of which such bodies are composed, causing the abstraction of some, the impartation of others, or the re-arrangement of the whole.

Caloric is the principle agent by which decomposition and recomposition is effected; and a variety of changes in bodies is attributable to it.

The particles of which all bodies are composed, are larger than the particles of Caloric; consequently the interstices, presented by the union of a number of spherical particles, are sufficiently large for the admission of particles of Caloric.

In proportion to the magnitude of the particles of which a body is composed, and their relative position, must be the magnitude of the interstices, presented by their union and arrangement; and on the dimensions of those interstices, and the extent of the power of attraction of aggregation, depends the recipient capacity of any body for Caloric.

In imparting Caloric to any body, the interstices are first filled; any further impartation has the effect of separating the particles, of which the body is composed, one from the other. The impartation may be continued, until the ultimate principles, of which the body is composed, are separated one from the other beyond the sphere of attraction of aggregation. While this process is going on, to the limits of attraction of aggregation, the body may be said to be in a state of expan-

sion; but the moment such limits are exceeded, the decomposition of that body commences.

In the decomposition of bodies, latent Caloric is set at liberty, and becomes free: hence all bodies in a state of fermentation, evince an increase of temperature, because being in a state of decomposition, much latent heat is converted into active.

Caloric contracts all substances holding fluids, in simple combination, by expelling the fluid.

Caloric is an indispensably necessary agent, both in the Malthouse and Brewery.

In Malting, it is an agent in germination and dessication.

In Brewing, it is an agent in solution and fermentation.

By the term cold, we are to understand an absence of heat or Caloric. No such substance or principle as cold exists. The sensation of what is termed cold, experienced by animals, is an extrication of heat from the body, in proportion to the sensation felt; and not an impartation of cold to the body. The warmth experienced by the wear of clothes, is not from an impartation of heat, effected by the clothes put on; but from the prevention afforded by them, to the escape of Caloric from the body. The natural impartation of heat to the body, is effected by the decomposition of atmospheric air by the lungs. In the natural process of breathing, the air, which is inhaled, is decomposed within the lungs. The effect of such decomposition, is the conversion of the latent heat, of such air, into active, and which heat is transmitted to the blood in its passage, through the vessels, in the immediate vicinity of the lungs, and is conveyed by the blood, in circulation throughout the whole of the animal system, and passes through the pores of the skin to the atmosphere, or other medium by which the body is surround-

ed. This transition of heat from the body to the surrounding medium occasions the sensation of what is termed cold; and the sensation is proportionate to the inequality of the supply and loss. And as the temperature of the blood of such as are in a good state of health, is about 98 degrees, any accession thereto, or diminution thereof, will yield an unpleasant sensation of heat or cold to the body, proportionate in intensity to the deviation from such standard point.

LIGHT.

Caloric and light are distinct principles, supposed to proceed from the same source.

Light does not pervade all bodies; some reflect, and others absorb, the rays of light.

It is a constituent principle of combustible substances, and is exhibited in their decomposition by combustion.

It is an auxiliary of Oxygen, and an agent in combustion.

It proves injurious in germination, and beneficial in vegetation; consequently the access of light to a Malthouse is an evil.

OXYGEN, OR THE ACIDIFYING PRINCIPLE.

Oxygen in an uncombined state, is not known.

Its known purest state, is in the form of vapour or Oxygen gas.

It combines with all metals, except gold and silver, with the aid of Caloric; but some metals require the aid of a considerable quantity of Caloric, to effect the combination.

What is commonly called rust, is Oxygen combined with metal; and by Chemists, termed an oxide of the metal, with which the oxygen is united.

An acid is the medium of union, between oxygen and gold and silver.

Oxygen gas is generally obtained from red lead, or black oxide of manganese, with the aid of sulphuric acid and caloric.

Oxygen gas forms 28 parts in 100 of atmospheric air, the remainder being nitrogen or azotic gas.

Without the presence of oxygen, combustion cannot be supported; the addition of oxygen to the combustible body, being indispensably necessary to support and continue the combustion of the body.

Oxygen and hydrogen united form water. Sulphur and oxygen, sulphuric acid, &c.

Oxygen is the chief principle of acidity; its presence is necessary to constitute a body an acid; and in proportion to its quantity, as a component part of a body, so is the intensity of the acidity of such body.

It is the principle in atmospheric air which supports life; the other principles united with it in the composition, are destructive of life.

Oxygen gas, pure and unmixed with nitrogen, would also prove destructive, by its powerfully stimulating effects upon the human frame; such powers are therefore diminished by the neutralizing effects of the nitrogen, combined therewith, in the composition of atmospheric air.

United with beer, wine, and a variety of fluids, it is productive of acetous acid, the which fluids having an affinity for oxygen, imbibe it from the atmosphere. Those substances which become acid by combination with oxygen, have peculiar bases, called acidifiable, or salifiable; many substances not possessing similar bases, but yet combine with oxygen, have no acid character.

The same substances are not always combined with an equal quantity of oxygen; the terminations ous and ic, as acetous, or acetic acid, &c. are not used to denote

the exact quantity of oxygen present, but to denote bodies moderately or considerably acid.

In the Brewery and Malthouse, it is a source of good and evil.

There is a point, the nearer approach to which, the presence of oxygen in quantity, the more beneficial. But beyond that point, the greater its quantity, the more prejudicial.

It is no small part of the Brewers' art to know how to command its presence, in sufficient quantity, and not beyond; and to place a barrier to its progress beyond the bounds of benefit.

Oxygen is a chief constituent principle of water, malt, &c. intimately combined with other principles.

NITROGEN

Is the basis of Nitric Acid (Aquafortis), but it is not evident to the senses in a simple state, other than that of gas.

In the state of gas, it forms about 72 parts in 100 of Atmospheric air, and is that part which neither supports combustion nor animal life.

It may be considered as an alloy to oxygen, and when combined with it, forming a salutary compound; when either in a separate state, would be destructive to animal or vegetable life.

Nitrogen gas being incombustible, it is procured by abstracting, from atmospheric air, its oxygen by combustion.

Nitrogen gas is considerably lighter than atmospheric air, and oxygen gas much heavier.

Without an admixture of oxygen gas, nitrogen gas is immediately destructive of life.

In respiration, the atmospheric air, which is inhaled,

is decomposed in the lungs, its oxygen is imparted to the blood, yielding to it its crimson colour, and the principle of life to the animal system, and the nitrogen is ejected from the lungs, which being lighter than atmospheric air, ascends. The short pause which occurs between respiration and inspiration, admits of the respired nitrogen, ascending sufficiently high before the act of inspiration commences, as to prevent the liability of the respired air entering again into the lungs. In crowded or insufficiently ventilated apartments, when the exit of the respired air and the ingress of pure air is not in the ratio of the respiration and inspiration of their inmates, then is the health affected in proportion to the difference, or to the constitutional powers of those who inhale the vitiated air, or to the situation and circumstances under which each individual may be placed.

Nitrogen gas being incombustible, extinguishes flame.

Nitrogen is also an inmate of the Brewery; it enters into the composition of Malt, Hops, Yeast, &c. It is a necessary principle in fermentation; and is useful in neutralizing a considerable portion of Oxygen, which might otherwise do much injury.

HYDROGEN.

Fifteen parts of hydrogen, and eighty five of oxygen, form water.

Hydrogen exists only in a state of combination, with other ultimate principles. It approaches nearest to purity, when combined with much Caloric, and in the form of gas.

In decomposing water, hydrogen gas is produced, whenever the oxygen of the water is absorbed by some other substance.

Hydrogen gas is twelve times lighter than common air.

Under certain circumstances, hydrogen gas is highly inflammable. It is only in consequence of strong attraction of oxygen, that hydrogen gas may be termed inflammable, as it is of itself incapable of supporting combustion.

Hydrogen also forms one of the constituent principles of coal, from which it may be extracted in the form of gas.

Hydrogen gas may also be combined with sulphur, phosphorous, phosphuretted hydrogen, and carbon, and is called sulphuretted hydrogen, and carburetted hydrogen.

Phosphuretted hydrogen has a fetid smell, and takes fire whenever it comes in contact with atmospheric air.

Carburetted hydrogen gas is produced in the distillation of coals; this gas is used as a substitute for other materials, in lighting up streets, houses, manufactories, &c.

Neither phosphuretted hydrogen gas, or carburetted hydrogen gas, will burn without the presence of oxygen. Both these gases burn in atmospheric air, in consequence of their affinity for the oxygen of the atmospheric air, causing its decomposition and the conversion of its latent heat into active.

Hydrogen also forms a component part of some of the materials used in the Brewery, as water, malt, yeast, &c.

CARBON AND CARBONIC ACID.

Carbon is found in a state of purity in the diamond only.

Combined with different portions of oxygen, it is met with in a variety of substances; and in that state of combination, is called carbonic acid.

The residuum, or ashes of burnt vegetables, is charcoal.

Charcoal is a powerful antiseptic, or enemy to putridity.

Carbon exists in varied proportions in vegetables, and is also a component part of wax, oils, gums, and resins.

Carbonic acid consists of carbon and oxygen, united in certain proportions; and this compound is found combined with several substances, termed carbonates.

Of all acids, carbonic is the most abundantly diffused throughout nature; but is best known in the form of gas.

The inspiration of carbonic acid gas occasions death.

It is twice as heavy as atmospheric air, and occupies the lower part, when disengaged from bodies.

It is a dangerous and destructive inmate of mines, wells, cellars, fermenting tuns, vats, &c. It is also disengaged abundantly from charcoal, in a state of ignition, which renders its combustion in close apartments dangerous, and often fatal to life; and on all occasions prejudicial to health, when the carbonic acid gas, disengaged, is mixed up with the atmospheric air, subject to animal respiration.

Carbonic acid gas will not support combustion; from the knowledge of which results the practice of discovering its presence, in wells, brewers' vats, &c. by suspending to a line a lighted candle, which is let down to such a distance, as is sufficient to extinguish the light, in case carbonic acid gas is present, or to the bottom, in case it continues to burn thus far; and without this preliminary test, no one should be allowed to descend into a well or vat, that has recently been emptied.

Lime, placed in carbonic acid gas, rapidly absorbs a very large quantity; and is the most prompt and effici-

cacious medium of withdrawing the whole, which may be contained in a well, or vat, &c. which may be most advantageously effected, by suspending fresh burnt lime in wicker baskets, just above the surface of the water in the well, or very near the bottom of the vat.

In the Malthouse and Brewery, carbonic acid is a most important and necessary product.

In the form of gas, it constitutes one of the inebriating principles in vinous liquors; and its presence affords an indispensable zest to the palate, and one of the indications of good quality.

ALKALIES.

Such as come under the denomination of carbonates, may occasionally be useful in the Brewery; their utility arising from the carbon, which is held in combination with other substances, forming the base of the compound, such as carbonate of soda, potash, &c.

When a vinous fluid holds oxygen in excess, or in other words, is become stale or sour, the acidity may be removed by the addition of a variety of carbonates; the effect of the addition being a combination of the carbon contained in the carbonate, with the oxygen contained in the fluid; which being united together, by the power of affinity, form a new compound, called carbonic acid: and when the presence of each is sufficient to cause the conversion of latent heat into active, and in sufficient quantity to convert the carbonic acid into carbonic acid gas, an escape of a portion of the latter into the atmosphere will take place, if the quantity created is more than the fluid will hold. By this means, if the whole of the acid, held in excess, combines with as much carbon introduced, as will convert the two principles into the new compound, called car-

bonic acid, then acidity is no longer discernible by the taste. But this remedy, so often resorted to, will not restore a vinous fluid to its primitive value, because its original value consisted in the quantity of spirit generated by fermentation, the quantity of carbonic acid it possessed, imparting vivacity to its appearance, and piquancy to its flavour, and the quantity of fermentable material yet undecomposed, giving a fulness and richness upon the palate, and proving the source of a continued supply of both spirit and carbonic acid, during the term of keeping and consumption; and as the excess of oxygen is but the result of a diminution of spirit, and of the fermentable extract, the addition of carbon will neither replace one nor the other. And again, as the carbon is accompanied by the base of the carbonate, the impartation of an ill flavour is the result, whenever it is administered alone.

In Chap. 12th, (FERMENTATION), will be found the right ingredients, their proportions, and the mode of using them, that will remove all acidity from any vinous fluid, without the impartation of any ill flavor, and render it fit to be got rid of by admixture.

ACETOUS ACID.

Acetous acid (Vinegar) is produced from a variety of substances, among which is malt.

Stale beer may properly be termed a mild acetous acid, and vinegar a strong acetous acid.

The difference in the quantity of oxygen present in each, constituting the cause of the difference in the acidity of each.

Fermented liquors, during the stages of sensible and insensible vinous fermentation, have attracted and absorbed much oxygen from the atmosphere. Such oxy-

gen has united with the carbon contained in the wort, must, &c. Such combination has produced spirit, carbonic acid, and carbonic acid gas.

In the manufacture of malt vinegar, the process is conducted on the same principles as the brewing of beer, except that no hops are used. The fermentation is carried further, and there is a subsequent exposure of the wort to the atmosphere which has passed the vinous fermentation, in order that it may absorb oxygen, which absorption is facilitated by caloric, proceeding from the sun, &c.

It has been stated, and I believe justly, that that vinegar is the strongest, which, when a vinous liquor, possessed most alcohol (spirit), and hence it is inferred that the alcohol is changed into acetous acid. However correct the first opinion may be, I can see no foundation for the latter conclusion; for as an analysis of alcohol will shew that its ultimate principles are hydrogen, carbon, and oxygen, it would be absurd to imagine that the hydrogen and carbon are converted into oxygen, during the process of acetification. But in looking to the following table, exhibiting the result of an analysis of pure alcohol, 100 parts, consisting of

Hydrogen	13,70
Carbon	51,98
Oxygen	34,32
	100,00

and also taking into consideration that the strength of vinegar is proportionate to the quantity of oxygen present, we must naturally come to the conclusion, that as oxygen is one of the constituent parts of alcohol, that the more alcohol a fermented liquor possesses, consequently the more carbon and oxygen it must also possess. And as to the affinity that exists

between carbon and oxygen, the absorption of oxygen from the atmosphere, is to be attributed; and as from experience we find, that affinity precedes union, and union extrication, and extrication is sometimes partially prevented; it is easy to account why fermented liquors often possess much oxygen, before the carbon has entirely departed.

And it is also equally evident, that as one of the constituent parts of alcohol is the acetous principle, and another of its parts possesses the power of attracting more of the acetous principle from the atmosphere, that the strength of vinegar must necessarily be proportionate in some measure to the quantity of alcohol previously present.

On distilling stale Beer or Vinegar, the acetification of which is not complete; the first product which rises is Carbonic Acid Gas; the next, Alcohol mixed with Water; and the next, Acetous Acid mixed with water. But on the distillation of vinegar, the acetification of which is complete, neither Carbonic Acid Gas or Alcohol form any part of the products; but acetous acid, diluted with water, called distilled vinegar, arises. Hence we learn that the whole of the Carbon which once formed part of the compound has been extracted; and as a considerable portion of Carbon formed part of the compound Alcohol, an extrication of such Carbon must necessarily destroy the compound. And if we carefully examine the laws of affinity and attraction of cohesion, we may easily perceive that a variety of compound substances, composed of the same ultimate principles, yet differing in the relative quantities of such principles, resist the efforts of decomposition, in proportion to their respective powers of attraction of cohesion. Thus we find that the attraction of cohesion which holds united the ultimate principles of Alcohol, more powerful than that which holds united the ulti-

mate principles of the dissolved materials of the Malt, which have not been converted into Alcohol, or disengaged in the form of Carbonic Acid gas, and thus the influence of decomposition, the consequence of affinity, effects a dissolution of the dissolved materials of the Malt, according to the respective powers of attraction of cohesion which each substance possesses.

WATER

Is a compound of 15 parts by weight of Hydrogen, and 85 of Oxygen.

Water holds a variety of substances, in a state of simple and combined mixture.

The decomposition of Water is effected by nature and art, in a variety of ways.

Vegetables and other substances have the power of decomposing water.

Water is purest in the state of hail, snow, and rain, or in rocky springs. The water of rivers and lakes is always mixed with foreign substances, imbibed from the soil, &c.

The putrefactive state of rain water, arises from ovala of animalcules, which become united with it in its descent.

Water exposed to the air, in stagnant ponds, tanks, backs, &c. receives the seeds of vegetables, which are conveyed to it by the air, and therein vegetate. Such water causes an injurious fermentation.

Fermentation is differently affected by the use of hard or soft water.

The principle which gives the title of "hard" to water, is an acid, generally derived from the soil in which springs are situate.

Water proceeding from Chalk may be both hard or soft, as there are two sorts of chalk: sulphate of lime,

imparting acid; and carbonate of lime, imparting carbon.

The solution of saccharum and fecula is prevented by acids; therefore in proportion to the quantity of acid present in water, so are its solvent powers diminished.

Water absorbs air, when exposed to it; and is deprived of it by boiling.

Air gives to water its lively and agreeable taste.

The thermometric heat at which water boils is dependant on the weight of the atmosphere; subject to such pressure, the boiling point is fixed at 212 degrees of Farenheit, liable to a slight variation. But such pressure removed, water boils at about 67 degrees; and if sufficient pressure is given, it may be heated to 400 degrees, without ebullition.

The caloric of fluidity of water is 140 degrees. (See Chapter on Caloric.)

Water is converted into vapour or steam, in consequence of Caloric combining with it.

Water, under atmospheric pressure, will hold in combination in a liquid state about 212 degrees of thermometric heat; and the same, in a state of vapour or steam. But to convert water into a state of vapour, between 900 and 1000 degrees, in addition to the 212 degrees of caloric, is necessary; but this extra quantity of caloric becomes latent, and the temperature of the steam is only 212 degrees of thermometric heat.

The expansive power of water, in combination with caloric, is immense; and in Mechanics, in the state of steam, it is rendered subservient to the most stupendous operations of art: but it is to caloric, that the energetic power is to be attributed.

The expansive power of water in freezing, is astonishingly great.

In the Malthouse, water is the vegetable food of grain, which is subjected to the process of Malting.

In the Brewery, water is the solvent of the soluble parts of Malt and Hops, and is a component part of Beer; and is an agent employed to effect cleanliness.

In some Breweries it is an agent, in the state of steam, employed as a motive power to the machinery of the establishment; and is also used to extract a certain portion of caloric from Wort, by means of a refrigerator.

FECULA (STARCH)

Is one of the component parts of grain. Its ultimate principles are Carbon, Hydrogen, and Oygen, in about the following proportions:—

Carbon - - - - - - - - - -	43,481
Oxygen - - - - - - - - - -	48,455
Hydrogen - - - - - - - - -	8,064
	100,000

Fecula is converted into Saccharum, by an addition of Oxygen, and an abstraction of Carbon and Hydrogen, as shown by the following comparative analysis:—

Carbon - - - - - - - - - -	37,29
Oxygen - - - - - - - - - -	55,87
Hydrogen - - - - - - - - -	6,84
	100,00

Fecula is insoluble in cold water, but is soluble in hot water of certain temperatures.

The proper temperature of water, which should be administered to Fecula, in order to dissolve it, is dependant on the quantity of caloric, which such fecula contains.

Fecula converted into Saccharum, remains in simple combination with Fecula unconverted.

The same principles added to and substracted from Fecula in a state of solidity, in order to form Saccharum,

if added to and substracted from Fecula in a state of solution, will produce the same substance. Thus, unmalted grain will produce spirit, in consequence of its Fecula being combined with such principles as are necessary in union to form Saccharum.

SACCHARUM (SUGAR)

Is a vegetable oxide with a double base, Hydrogen and Carbon, brought to the state of an Oxide by a certain proportion of Oxygen. These three elements are combined in such a way, that a very slight force is sufficient to destroy the equilibrium of their composition.

Most kinds of grain contain the principles which form Saccharum, but the process of germination is needful, to place such principles in a suitable state of arrangement, as is necessary to constitute Saccharum.

Saccharum decomposed by vinous fermentation, furnishes Alcohol and Carbonic acid.

In the Malthouse, Saccharum is formed in the process of Malting, by a new arrangement of the principles of which the grain was originally composed; and by an abstraction of part, and the addition of others, from water and air, by the agency of fermentation.

In the Brewery, it forms the chief and most valuable ingredient in the composition of Beers.

GLUTEN

Is also a component part of grain.

The ultimate principles of Gluten, are Carbon, Hydrogen, and Oxygen; and with them are combined a small portion of Nitrogen.

Gluten is a substance composed of the same principles as Fecula and Saccharum, but varying in proportionate quantities. But the presence of Nitrogen gives it

characteristic properties, differing from Fecula and Saccharum.

Gluten in solution, will not pass into a state of vinous fermentation, owing to the presence of Nitrogen.

From its viscosity, Mucilage serves to render Oil miscible with water.

Gluten in a state of solution with Fecula and Saccharum, is coagulated by boiling and fermentation, and is ejected from the Wort.

Gluten is supposed to be the true fermenting principle.

Extracts from some vegetables possess a sufficient quantity of gluten to promote the vinous fermentation, without the addition of any fermentative substance.

I should imagine that a considerable part of the Carbonic acid, which is generated in fermentation, unites with the gluten, ejected; and which combined, forms Yeast. And that such gluten by affinity, holds in simple combination the Carbonic acid; and that Carbonic acid is the true fermenting principle, and the gluten merely the retentive substance, with which it is combined; for we find the fermentative powers of yeast depends on the quantity of Carbonic acid which it possesses, and that if such Carbonic acid is evolved in the form of gas, the remaining substance is destitute of all fermenting powers. Such an opinion is corroborated by the fermentation resulting from the use of Carbonates.

BITTER PRINCIPLE.

This principle is found to exist in a variety of substances.

An essential and gross oil, and an alkaline base, are the most obvious principles which enter into the composition of Hops.

The analysis and characteristics of the bitter principle appear to have had but a small share of the attention of the Chemist.

Of the known variety of Bitter substances, none are so suitable for the use of the Brewery as Hops, all other substances being deficient in the peculiar flavor possessed by Hops, and of themselves possessing an unsuitable flavor.

The preservative powers of Hops are supposed to be vested in the alkaline base, which neutralizes a very considerable portion of the acetous principle (Oxygen) absorbed by Beer, from the Atmosphere; The Carbon of such base uniting with the Oxygen as it is absorbed, and forming Carbonic acid gas.

The oil of hops may also be considered as operating in assisting and producing the same effect in a minor degree. This substance intimately blended in the body of Beers, gives them an agreeable softness and flavor.

A THEORETICAL AND PRACTICAL

TREATISE

ON

MALTING AND BREWING.

CHAP. I.

MALTING.

The art of Malting consists in dis-arranging and re-arranging the several principles of which the grain submitted to the process is composed; and to abstract such principles therefrom, as are inimical to the properties of the altered substance, and to impart such as are necessary to form a component part of the new compound. To effect this, it is necessary that the manufacturer should obey the Laws of Nature and of Science; and the commencement of his labours, is germination.

Having treated of the various principles, which constitute the component parts of grain, in the introductory pages; the next subject which naturally claims attention, is germination, as effected in the field, and in the Malthouse.

For the sake of distinction, we will call the process in the field natural, and in the Malthouse artificial.

In the former case, the grain is imbedded in the earth, at a sufficient depth to secure sufficient stability to the plant, when arrived at maturity; at a sufficient distance from the rays of heat and light, as is necessary for the accomplishment of the process of germination; and at such a depth, as furnishes a matrice, at an equable temperature, all the year round, of about 50 degrees; surrounded by earth, impregnated with moisture, and pervious to atmospheric air. Thus placed, it slowly and gradually imbibes a sufficient quantity of moisture, as is required to ensure a commencement of the process, and a sufficiency in continuation, to carry it on to completion.

But in the Malthouse, a close copy of the natural process of germination is prohibited by Excise restrictions, and the prompt and brief requirements of Business; and hence it becomes necessary, without losing sight of the natural process, to call in the aid of Science, to effect advantageously, in a short time, that which, by the natural process, requires a much longer period.

But to discuss this subject with perspicuity, it is necessary first to describe the substances and their proportions of which grain usually submitted to the process of malting is composed. And as this grain is usually Barley, in consequence of its better adaptation to the several purposes, I shall confine myself more particularly to its description, at the same time observing, that other grain is composed of the same substances, yet varying in the several quantities of each.

The following comparative analysis of unmalted and malted Barley, shows what are the component parts, and their amount, as also the change which takes place in the operation of malting; and referring to the introduction, under the heads of Fecula, Saccharum, and

Gluten, it will there be found what are the ultimate principles of which these substances are composed.

Gum	5	- - - - - - - - - -	14
Sugar	4	- - - - - - - - - -	16
Gluten	3	- - - - - - - - - -	1
Starch	88	- - - - - - - - - -	69
	100 Barley.		100 Malt.

From the preceding statement, it is not to be inferred that all Barleys are composed of the same quantities of the substances mentioned.

Indeed, the diversity in quality of grain arises from the difference in the quantity and proportion of such substances as, together combined, make up the body. Hence grain grown on peculiar soils, is generally considered of better quality than the same species in soils of a different class; arising from the difference in the quantity, of those superior principles, which are afforded by the better adapted soils, and the more favorable circumstances, under which they are, with more facility, imparted to the grain, during the process of germination and vegetation; not that the grain derives any of the principles alluded to from earth itself, but from various substances blended with it.

The earth, in this instance, is but nature's vegetative womb, which becomes a depository of all those principles which are imparted to it; and which are necessary to the growth of grain.' Hence such soils as are best adapted for the reception, and impartation of such principles, are the best for the purpose of its growth.

Neither does the successful culture of grain, depend on the suitable capacity of soils alone. In vain are the liberal labours, and gifts of the Agriculturist, if nature imparts not those suitable and indispensable principles, which man cannot command. It is not the

mechanical culture, the scientific administration of suitable manures, that can command an abundant or a valuable crop; not but what all these things are necessary to be done, and those who carefully and skilfully perform them, may expect a more successful issue than those who do not; yet it is the hand of Providence, by natural agents, which gives the increase.

The principles necessary to the growth of grain, are those of which air and water are composed; it is therefore necessary that air and water should have access to the imbedded grain; hence a sandy soil, upon a chalky base, is generally considered best for the growth of Barley, the porosity of such a soil admitting, with facility, water and air.

In the statement, indicating the substances and their quantity which combined make up the body of unmalted and malted Barley, it will be found that Fecula or Starch forms the principal component part of Barley as to quantity; and as in the process of malting, Fecula, by the addition and substraction of certain principles, is converted into Saccharum; and as in the process of fermentation, it is the Saccharum only which is convertable into spirit; and as it is the spirit generated, which gives to beer and other vinous fluids their strength, or in other words, their inebriating properties, hence it necessarily follows, that Fecula is the most valuable part of Barley, and that such Barley as possesses most, is the most valuable, and best suited for the purpose of malting. To form a just estimate of the value of Barley, by being able duly to appreciate the superiority as to quantity of Fecula, in different samples, requires judgment; and an experience founded on close and attentive observation. If this is the case, and I trust that the truth of the statement cannot be disputed, it must be obvious, that the acquirement of this discriminating experience is truly desirable, and

forms the basis of the qualifications of a Maltster, to conduct his business to advantage.

I cannot here refrain from attempting to combat the prejudices, and false notions, which are too generally entertained, relative to an estimation of the value of Barley. One individual will think himself quite sure of meeting with a good sample from a reputedly good soil; and will purchase, in security, without appealing to the evidence of his senses. Another judges the value by the weight, which the scale indicates, without considering the value of the predominating substance, which gives the preponderance. Another, if he can purchase an inferior Barley at a low price, thinks such an article better bought, than a better Barley at a higher price. And others are influenced by outwardly fair appearances, in making their choice.

To the first I would say, that good grain is not always produced on a reputedly good soil; and that acknowledged inferior soils will sometimes produce a better sample, though not generally. To the second, that that substance in Barley, the least valuable, is the most weighty. To the third, that the value of Barley is not to be judged by the quantity or measure of the grain you can obtain for a certain sum of money; but by the quantity of those essential principles, you need for such a sum. To the fourth, that a large quantity of those principles, most needed, are sometimes enveloped in a skin of unpromising appearance. And to all I would say, be governed by the quantity and state of those substances which constitute the value of the grain, submitted to your inspection.

The first and principal object of the Maltster should be to purchase Barley, containing the most Fecula; and the best practical guide to the judgment, with which I am acquainted, in discriminating, is, to examine the sample, and, by the exterior, to determine,

if it has been thrashed, without unneccessary bruising. If it has been well winnowed and screened, and appears to possess an evenness of bulk; has not been mixed with grain of another species, or of the growth of another field; is free from any, or many damaged corns; and if it presents generally a well grown, well harvested, well housed, well made up, and a heavy Barley. The exterior proving satisfactory; the interior must be examined, by biting asunder a few grains taken indiscriminately from the bulk; and if the internal substance is white, and what is technically called free, throughout, it denotes the presence of plenty of fecula, and that it will work well on the floor, and yield well in the Mash Tun. But if on the contrary, the internal substance presents a close, compact, smooth, and horn-like appearance, which is technically termed flinty; then is there a decided proof that such grain has either not been grown on a good soil, or that it did not ripen well in the field, or not of a right species, for malting to advantage, or that it has not sweat in the Mow; and the necessary conclusion is, therefore, that it will not work kindly on the floor, nor spend well in the Mash Tun. But should he, as is very frequently the case, be obliged to purchase Barley in an unfit state, for malting, or it becomes an alternative, either to purchase a very light free Barley, or a heavy flinty one, and his judgment determines to the latter; he ought then, by the aid of art, to endeavour to improve that which he is compelled, or chooses to purchase; which may sometimes be effected by a careful sweating in the Store-room, or on the Kiln; effecting, by art, that which has not been done by the sun and air in the field, or by fermentation in the Mow.

The criteria which I have endeavoured to furnish, to assist the judgment in the selection of Barley, for malting, must not be considered as unexceptionable;

because a heavy flinty Barley may possess much fecula, the amount of which is not discoverable, by the ordinary means of inspection, because such fecula is obscured by the presence of those principles, which, to constitute it a Barley, in a fit state for malting, should have been abstractad, previous to a purchase for the purpose. And if the Maltster can by any means ascertain, or believes that such is the case, and is conscious that he can by art, abstract such principles; a Barley, of unpromising appearance, may, in his hands be converted into good malt.

But to explain and comprehend this subject more fully and clearly; it is necessary that we should descriptively trace germination, from its first stage, to vegetation in its last.

The body of grain consists of two essential parts, the germ or small bud, and the cotyledons or seed lobes. The first is the part endowed with life, and the rudiment of the future plant; and the second, the depository of nutritious matter, such as the germ in a state of growth requires, and which nutriment is conveyed to it by slender vessels, which ramify through the whole body of the grain, as veins convey the blood throughout the animal system. In the germ, two distinct parts are discernable, the radicle, which descends from the seed, forming the root; and the plumula, or acrospire, forming the stem.

When the seed is placed in the ground, or in other situations favorable to its growth, it absorbs moisture and swells, the radicle begins to shoot out, and at the same time, the substance in the seed lobes, suffers a change in its qualities, the Fecula, of which it consists, being converted into Sugar. This constitutes the vegetable function of germination, and, when performed on certain grains preliminary to fermentation, the process of malting.

It has been ascertained, that oxygen is indispensable to germination. Seeds moistened and placed in vacuo do not germinate, nor yet if confined in Nitrogen, Hydrogen, Carbonic acid, or Nitric Oxide gases, or if placed over Quicksilver.

When immersed in water, from which atmospheric air is excluded, they swell, and the radicle is formed, but vegetation makes no further progress, and in all these cases, if the seed has been moistened, the life of the germ is soon lost, the matter of the seed soon decomposes, and becomes putrid, and a portion of gas, consisting of carbonic acid, and carbonic oxide, or carburetted hydrogen, is disengaged.

When Atmospheric air, or oxygen, is admitted to the moistened seed, germination soon commences, and at same time oxygen is consumed, and carbonic acid is formed,

Germination is even more rapid in oxygen, than in atmospheric air.

It appears so far as the fact is yet ascertained, that there is reason to believe, that in germination, beside the abstraction of Carbon, by the action of the Oxygen of the air, there is a decomposition of a portion of the water, and an addition from this decomposition of oxygen, and hydrogen, to the matter of the seed.

The action of the Oxygen appears to be the efficient cause of the abstraction of the Carbon, the chemical affinity between them, causing their combination, leav- the other elements in that proportion and condition which produce Saccharine matter, while the circumstances which favor these combinations, particularly heat and moisture, equally favor the evolution of the germ.

A certain temperature is essential to germination. If it be below the freezing point, no seeds germinate, and the greater number require a temperature considerably higher.

Light does not forward, but retards germination; as light by its chemical agency is always an antagonist to the combination of oxygen; and as this combination, at least with the carbon of the seed, is necessary to germination, it is probably to this operation, that the influence it has on the process is to be ascribed.

By the chemical change which occurs in germination, the Fecula of the seed is converted into Saccharine matter; its taste becomes quite sweet, and it affords a portion of sugar on maceration in water. This Saccharine matter appears to serve as nourishment to the infant plant, for being soluble in water, which the Fecula is not, it is capable in this state of solution, of being absorbed by the vessels of the radicle, which begin now to expand, and which ramify through the substance of the seed; and thus in the first stage of its growth, the plant has a supply of nutritious matter, independent of any external source.

Regarding germination as its first stage, the seed exposed to humidity and atmospheric air expands. Its farinaceous matter, by the oxygen of the air, is converted into sugar, which serves as food to the infant plant. Its organs are gradually unfolded, and its nourishment is soon received from a different source. Water, pure, or holding vegetable or animal matter in solution, is absorbed by the roots, and different aerial fluids are likewise received and mingled with the sap, which, in its progress through the root, dissolves part of the vegetable matter, and from these several supplies of nourishment, the plant, in the first stages of its growth, receives continual accretion to its various parts. This nutriment is conveyed by capillary attraction to the leaves of the plant, and is there presented under a very extensive surface, covered with a very thin membrane, to the action of the air and light; part of its water transpires, carbonic acid, in minute quanti-

ty, is perhaps absorbed, and by the action of the vessels, assisted by the chemical agency of light, new combinations are established, and the proper juice is formed, which is destined to continue to nourish the plant, and which is, for such purpose, conveyed by the footstalk of the leaf, through vessels proceeding downward, through the bark, or between it and the wood. By such conveyances, it is deposited in different parts, and is still further changed in its progress, from which changes result the formation of the several peculiar products of the plant.

From this view of the process of germination and vegetation in the field, we may learn that a perfect seed is requisite to a perfect product; and favourable circumstances, throughout the growth, to ensure its perfect completion. The constituent requisites of a good seed, are a perfect germ, and cotyledons, as the vegetable functions; and plenty of fecula in right condition, as the early nutriment of germination. If from untoward circumstances, the grain in the ear has not attained to a perfect maturity; neither the germinative functions, or the fecula of such grain, can be in a fit state for germination, either in the field or Malthouse. And if the immaturity of such grain arises from an inadequate supply of heat by the Sun; the Maltster should, previous to the steeping of such grain, endeavour to abstract those principles which yet remain blended with the fecula, and the abstraction of which remains to be performed to effect maturity. And as I have before observed, sweating in the Mow, or Store, or on the Kiln, is the best expedient he can resort to.

From a review of the process of germination in the earth, we may obtain some valuable hints as to what it should be in the Malthouse; and as close an imitation as Excise restrictions and other circumstances will admit, should be adopted by the Maltster, throughout the whole of his operations.

The hints furnished, are:—First—The placing the grain at a sufficient depth, within the earth, beyond the access of light:—Second—At a depth also, where the temperature of the earth is, uniformly, at about 50 degrees:—Third—Under such circumstances as admit but of a gradual and continuous impartation of moisture. Fourth—The conversion of the fecula into Saccharum, for the purpose of affording nutriment to the root and acrospire, until the process of vegetation succeeds that of germination, and external nutriment is needed and obtained to carry on the work to completion.

From the first hint we may profit, by admitting no more light to the working floor than is sufficient for the purposes of turning, raking, &c. and such admission should be independent of a consequent admission of air. When natural light can be obtained, artificial should be avoided; as when light is obtained by combustion, there must be a consumption of oxygen to support it; and to consume oxygen unnecessarily in the working floor, is to rob the grain of that principle which it needs to carry on the process of germination.

In the second case, the temperature of the working floors might, by artificial means, be kept at about 50 degrees of heat, without depriving the air contained in such rooms of its oxygen, for the purposes of combustion of such fuel as might be employed to generate the needed heat. Pipes passing throughout the working floors, to a sufficient extent, for the passage of Steam, the supply regulated by a stop cock, to raise the temperature to the required point when below, and through which pipes cold water might be allowed to flow, when the temperature of the rooms were above such point, appears to me to be the most suitable method to accomplish the object. And if the Excise restrictions did not exist, it appears to me, theoretically correct, that an occasional supply of steam, so as to

fill the whole of the working floors, might sometimes be resorted to most advantageously, as a substitute to sprinkling with cold water, and to promote the growth of the grain. But on this subject I am destitute of practical information, and while the Excise restrictions continue to exist, all enquiries and practical demonstrations appear to promise but an unprofitable result. But independent of artificial means, to raise or reduce the temperature to about 50 degrees, a skilful and intelligent Maltster may find ample employment for his judgment, in devising and practising means, to keep both his corn upon the floor, and the room, at about the right temperature; and to aid him in such purpose, he would find the Thermometer useful. While grain is in a state of germination, a very considerable quantity of latent heat is rendered active, in consequence of the decomposition which occurs, and which heat, combining with the Carbonic acid created, converts it into Carbonic acid gas. This gas being heavier than atmospheric air, while at the same and certain higher temperatures, floats at a distance above the Corn upon the floor, proportionate to its specific gravity, governed by its temperature, to the air within the room. As the absorption of Oxygen from the Atmosphere, by the grain, is necessary to carry on the process of germination, and as the consequences of such absorption is the formation of Carbonic acid, and the formation of Carbonic acid is the result of decomposition, and decomposition converts latent heat into active, and the active heat, combining with the Carbonic acid, changes its specific gravity, and thereby enables it to leave the grain and rise in the circumambient air; so is it necessary that such Carbonic acid gas should be removed from the grain, to relieve it of that which it has ejected, and to make room for pure atmospheric air, to supply its place, for the impartation of more oxygen.

To effect this removal, the operation of turning and raking materially assists; effecting, by the consequent agitation, an admixture of the gas with the atmosphere, and a diffusion of the active heat referred to, throughout the room. To prevent an accumulation of too much heat and Carbonic acid gas in the room, it is necessary occasionally to open the windows, for the double purpose of allowing the heated and vitiated air to escape, and pure air to enter in to supply its place. Here then is required an exercise of the Maltster's judgment, in opening as many and no more windows than is necessary for the purpose; to open those which are necessary, on the most suitable side of the house; and sometimes on both sides, when a current of air will best serve his purpose. To open them also at the most suitable time, and to shut them as soon as the purpose is served.

From the third hint the intelligent Maltster is likely to derive more vexation than profit, from the consideration that the rapacious Excise Laws prevent him from copying Nature in this department of the process of germination. "It shall remain so many hours in steep," authoritatively says the Law. "And you shall not sprinkle, before a certain number of days have expired from the time of throwing out of Couch," again exclaims the Law. And why? Because the duty is not charged on the quantity of the dry Corn which is steeped, but upon the bulk it assumes, in consequence of being steeped. The Law virtually says, "steep it so many hours, and it shall be saturated with water, until it attains in bulk to the limits of capability, and then I will charge the Duty at whatever point of the process of making I can find the bulk the greatest. Dont tell me that, in order to make the best Malt, you ought to imitate Nature as far as you can; that will not yield me the best Duty. Steep it well and make bad Malt, and they will want to use more of it, and thus

I shall doubly gain my point." Such is the effective operation of the Excise Laws, and while the restrictions are continued, the hint is of no more value than to choose a point of time within the scanty range, "not more nor less than —— hours," which are prescribed, as will best accord with the state and quality of the grain to be steeped, coupled with the subsequent restrictions.

The fourth hint supplies the full and entire purport of the process of Malting. On reference to the comparative results of barley and malt, it will be found, that in conversion from one state to the other, there is a great increase in the gum and sugar, and decrease in the gluten and starch.

We have endeavoured to show, that in the process of germination in the field, the conversion of fecula into saccharum is for the purpose of supplying nutriment to the root and acrospire, to enable and promote their growth; and as all the arrangements of Providence are perfect, and who has devised the means competent to realize the end, there can be no doubt, but that in perfect grain, the supply of fecula is adequate to the demand of the root and acrospire, until they have attained to that state, when they naturally obtain it from another source. In the process of germination and vegetation, the ultimate purpose of Nature is reproduction of the same species, and with considerable increase. The Maltster's purpose is to create as much saccharum as he can, and not lose it. To effect it, germination is absolutely necessary, and he must follow Nature so far in the process, as is necessary to convert as much fecula into saccharum as can be effected without expending it more than can possibly be avoided, in bestowing nutriment on the root and acrospire, than is sufficient to develope their functions with moderate speed, and to a limited extent. In the manufacture of beer, the root and acrospire afford no beneficial ingredient; therefore

their growth as relates to their supply is useless; but still the conversion of the fecula into saccharum is indispensably connected with their growth, and all that the Maltster can do is, to prevent an unneccessay loss of saccharum, in carrying on their growth with unnecessary speed, or beyond the required limits of his purpose. The Maltster who manufactures for sale, is interested in allowing the acrospire to grow to a greater extent than the Maltster who makes for his own consumption, in the double capacity of Maltster and Brewer; because by such means he can obtain a greater increase, and consequently a greater profit; and by adventitious means also, he can make up an apparently excellent sample to the eye of the inexperienced. This is effected by working up the back well, as it is technically called sprinkling, a short time before it goes on the kiln, slightly blowing it on the kiln, and the occasional use of sulphur, for the purpose of bleaching. The effect of what is called blowing on the kiln, is to distend the grain in bulk, by converting the water imbibed by the grain, in consequence of sprinkling, into steam, which acting expansively, distends the grain in every direction, giving to the malt a plump and fair appearance to the eye, and as a matter of course measuring, what is called, well. This system is much practised in drying off brown porter malt, and the blowing is carried to a greater extent than with pale malt; and the consequent increase is very considerable; amounting in my own experience to three bushels, two gallons per quarter; or in more expressive terms, that eight bushels of barley will furnish eleven bushels two gallons of blown brown Porter Malt.

But the Maltster, for his own consumption, works what is called close: which consists in working but little root and back, and yet getting his corn mellow; and to effect this, it is necessary that he should work

his corn cool and slow, and furnish every facility to the free escape of the carbonic acid gas created, and the impartation of oxygen, by allowing the access of a suitable quantity of atmospheric air. By working cool, he does not furnish a stimulus to the rapid growth of the root and acrospire, which would rob him of his saccharum; and by promoting the free and prompt escape of the carbonic acid gas and the access of air, he carries on to the most profitable extent the process of decomposition, by abstraction and impartation, obtaining a full supply of saccharum, without much growth of the root and acrospire.

I think no one will deny, that it is quite desirable, before we attempt to imitate, by Art, the operations of Nature, that we should be well acquainted with the general and peculiar laws by which she is governed in performing her operations; and with the nature, quantity, and properties of the materials she employs in producing those substances which are the subjects of imitation, and the mode by which she abstracts and imparts the needed principles, and what are the agents she employs to aid in effecting it. And thus far I have endeavoured to convey to the mind of the reader, a clear and succinct view of the theory of the process of Malting; and my next business is to furnish a similar view of the practical process.

Having adverted to the state and quality of the barley, which should be purchased, if possible, for the purpose of Malting; the Maltster's attention is required to the adoption of such means as are best adapted to the separation of such portion from the bulk as will not grow, or are not worthy of growth. Although separation to a desirable extent cannot be effected, yet there are several considerations to induce it, as far as it can be beneficially performed, by the best means that can be devised. The same duty is paid upon bad Malt as upon

good. The produce of very thin light corns, is not worth the amount of duty. The rapidity of their growth, compared with the heavier grain with which they are mixed, render it difficult for the Maltster to know the best way to act; the alternative being presented to him, of either letting the light grain run to waste, while he is bringing up the heavy, or prematurely stopping the growth of the heavy, to prevent the wasteful growth of the light. All bruised, broken, and damaged grains will not grow, but are subject to a putrefactive fermentation, consequently their presence is not negatively useless, but positively injurious; and had they been, previous to wetting, abstracted from the bulk, they might have been turned to a good account in several ways; whereas, by their remaining, a heavy Duty is paid on a putrefactive substance, causing to the Brewer an absence of profit, and the presence of ill flavor, as well as absence of saccharum, and consequently not the presence of good quality to his Beers. I might, also, refer to the beneficial separation of the flinty from the free, the mow burnt, such as have commenced growth previous to purchase, and other peculiar states and conditions of bad grain mixed with good, the purchase of which either in an unmixed or mixed state is best avoided, if possible; and if not possible, the means of separation being beyond our power, or if within, too expensive and troublesome to induce the separation, and therefore I shall confine myself to the recommendation, of an attempt to separate the light and broken only; conceiving that mechanical means may be devised cheaply to effect it. It is a rule with many to get the steep water into the cistern first, and to let the barley slowly run into it from a store above, and to skim off all the light grains and rubbish that float on the surface. The objections to this method are, that many light grains that would swim, are prevented by being kept under by

heavier grains that fall with them. And many that would not rise, if unrestrained by any impediment, it would be much more profitable to separate from the bulk, than let them remain. And none of the broken corns will float, whose specific gravity is greater than the water in which they are steeped. A winnowing machine, constructed on such principles as will blow the light and broken corns from the sound and heavy in the passage of the latter into the cistern, is the best method I have yet seen adopted.

The temperature of the steep water ought to be as near 50 degrees as possible, provided the barley to be wet is at such a temperature; but if it is above or below, then the heat of the steep water should be such as would render the mean temperature of the water and barley mixed at 50 degrees. Every Malthouse should be furnished with the necessary apparatus to raise the heat of the steep water to the required point, and the best measures taken to prevent the use of water at a higher temperature, as far as is possible. The temperature of water in a well, is at about 50 degrees all the year round, and when water is pumped therefrom direct into the cistern, it will be found seldom to vary much from the heat required. But many adopt the method of supplying the barley cistern with water from a Tank, wherein it may have remained sufficiently long to be raised or reduced to the heat of the atmosphere, or to the freezing point, or any point between. As germination cannot favorably commence at a less temperature than 50 degrees; if barley is wet with water so that the two when mixed are of an average temperature below or above that point, so in proportion to the distance below or above that point, will be the disadvantages under which such barley will commence the process of germination. By this injudicious and injurious system, I have known grain to nip in the cistern; and I have known it to be thrown from the couch, in as thick a heap

as possible, and well covered with sacks until it has nipped, which has not occurred until a considerable time had elapsed. The resulting consequence in the first case was,—that having to lay in the couch thick, during the time prescribed by Law, the rapidity of the process of germination was such, before it could be thrown thin upon the floor, and the acquired temperature so great,—that the injury sustained could not possibly be effaced by any subsequent remedial measures. In the latter case, the heat required to raise the temperature of the whole mass of grain to the point at which germination would commence, was acquired by converting latent heat into active heat, by decomposition. Thus the decomposition of the constituent principles of the grain, and the water imbibed, which ought to commence and progress simultaneously with the growth of the root and acrospire, was prematurely commenced in order to generate the heat necessary to cause the growth of the living principle to begin; and as in the absence or in the dormant state of the living principle, the decomposition of vegetable matter must be putrefactive; so in this state, a putrefactive decomposition was resorted to, to raise sufficient heat to stimulate the living principle into action; and in proportion to the extent to which such putrefactive decomposition was carried, before the living principle was awakened, so was the injury sustained. And not only thus far, but incalculably farther, because the water which had been imbibed in the cistern to serve the process of germination, until the grain reached the kiln, or until the Law allowed an addition by sprinkling on the floor, was expended partly in generating the necessary heat to cause germination to commence, instead of being preserved to aid and facilitate its progress. Nor can the injury sustained in such a case be appreciated by any calculation, for if the grain had lain in that state, until the external surface had acquired a temperature of 50

degrees, by a transmission of heat from the inner and lower surface, the heat of the latter must have been raised to a much higher point than 50 degrees; and by the time the external surface had nipped, the internal must have been in a very forward state of germination; and whatever may have been the internal and external temperature of the grain when moved, the difference must have yielded most injurious results. It is to be hoped that such extreme cases but seldom occur; but that approximating cases, varying in proportionate distances, do frequently and continually occur, I do not doubt. Having suggested the propriety of causing the steep water and barley, in a state of admixture, to be at 50 degrees or thereabout; it seems an almost superfluous task to describe the necessary measures to be taken to accomplish it; but as the most simple means to effect it may not, without reflection, occur to every one, I will endeavour to point them out. Suppose it is required to wet 20 quarters of barley weighing 50lbs per bushel, at 40 degrees of heat, with (for illustration sake), 40 barrels of water, weighing 360lbs per barrel; what should be the temperature of the water, so that the mean temperature of the mixture should be 50 degrees?

20	quarters of Barley
8	
160	bushels of ditto
50lbs	per bushel
8000	weight of 20 qrs. barley
40	
320000	weight and heat of 20 qrs. ditto
40	barrels of water
360lbs	per barrel
2400	
120	
14400	weight of 20 bushels of water

14400 weight of 40 barrels of water
8000 ditto of 20 quarters of barley

22400 ditto of water and barley
50 mean heat required

1120000 heat of water and barley mixed as required
320000 weight & heat of 20 qrs. of barley, deducted

14400)800000(55½ degrees of heat, at which the steep water should be.
72000

80000
72000

8000
4

14400)32000(2
28800

3200

The construction of a series of Tables, to prevent the necessity of calculating each wetting at the time, might be previously effected, and referred to when needed. A steam apparatus for the double purpose of heating the water in the cistern to the required point, and warming the floors, &c. when needed, I should recommend as the most suitable.

Pure water for the purpose of steeping should be used, and a sufficient quantity let into the cistern as will cover the barley after it has swelled, rising 3 or 4 inches above its surface.

The time which barley should lay in steep, must depend on the time prescribed by Law and the Maltster's judgment, so far as the Law will allow him to judge and act for himself. No precise rule can be laid down as relates to the time which barley may most advantageously lay in steep, the Maltster's experience must determine it, he being governed by the state and quality of his barley, the temperature of his working floors, &c. and his system of working.

The steep water may, in warm weather, be most

advantageously changed two or three times during the prescribed period the barley must lay in steep, and the same in cold weather, provided the renewed water is at a temperature of 50 degrees; and the steep water should run off with speed, in order that the oil extracted from the husk, may not be so liable to adhere to the grain, as it would be, if run off slow.

As the Law prescribes the time and circumstances relative to the grain lying in the couch, it appears to me necessary only to suggest that the couch frame should be made sufficiently large, so that the grain may not lay too thick, lest germination should advance too rapid and too far before the Law will allow it to be thrown out. At the termination of the time prescribed, it is desirable that the grain should have no more than just nipped.

Up to the period of nipping, the process of germination may be thus described:—the grain while in the cistern, in steep, absorbs a considerable quantity of water. The ultimate principles of water being solid oxygen and hydrogen rendered fluid by the presence of caloric; and a powerful affinity existing between the oxygen of the water and the carbon of the seed, decomposition of the water necessarily ensues, and a portion of the oxygen combining with the carbon, forms carbonic acid. And the liberation of caloric (ever consequent on decomposition), converts the carbonic acid into gas, which quits the grain by transpiration. Another portion of the oxygen uniting with the remaining portion of the carbon, forming one of the component parts of the fecula, saccharum is consequently formed; and the remainder of the oxygen with the hydrogen, unite with the other parts of the grain, giving to such parts their characteristics, which, in transmutation from barley to malt, they acquire. The decomposition of the water and the grain in this operation, necessarily liberates the latent

Caloric, which rendered such water fluid; and passing from a latent to an active state, becomes demonstrative to the sense of feeling and sight, by placing the hand or a thermometer in the heap. The heat therefore, which a heap of wet grain acquires, is not obtained from the atmosphere, or any contiguous bodies, but is a heat produced by the joint decomposition of the grain and water to a certain extent.

The quantity of oxygen which it is necessary should enter the grain for the purpose of extracting the Carbon and uniting with the Fecula, is not only derived from the water, which was absorbed by it in the Cistern, but an absorption of atmospheric air is subsequently necessary, in order that an additional quantity of oxygen may be furnished by its decomposition; and should be continuous during the process of germination.

From what has already been said, it appears that, by the process of Malting, the internal parts of the body of grain undergo a change, by the abstraction and impartation of principles; which principles imparted, are derived from air and water. And to carry on this process to a state of perfection, the abstraction and impartation should not exceed or fall short of a certain yet indefinite point.

In proportion to the quantity of the principle necessary to be extracted, which such grain possesses, so must the extracting principle be administered; and in proportion to the quantity of the recipient principles, which form the body of the grain, so must the imparting principle be administered. Thus if grain possesses much Carbon, much oxygen must be imparted to extract a sufficient portion; and if grain possesses much Fecula, much oxygen must be imparted, to unite with it to form Saccharum. And as much Caloric is necessary to act as an agent of impartation of oxygen, and extrication of Carbonic acid; much water is necessary to

assist in furnishing the quantity required, and great care must be taken that too great a quantity of Caloric does not escape, lest its work of agency should not be complete, by the time it is quite expended.

The following effects frequently produced and well known to most Maltsters, are sufficient to prove the correctness of the preceding observations. In submitting them to the reader, I shall indulge myself with further remarks, illustrative of the causes and operations which produce them. Barley will not vegetate in a situation where it is exposed to a very cold atmosphere.

The Maltster, having to practice under these circumstances, lays his corn very thick, and covers it over; and he then often finds that the outer grain does not germinate, while that which is beneath does.

The law of equalization to which Caloric is subject, causing the Caloric, which is liberated by decomposition, and which has passed from a latent to an active state, to pass from the corn to the atmosphere, instead of remaining in the grain, until it has performed its operation as an agent of abstraction and impartation; consequently the extraction of Carbon, and impartation of Oxygen is not effected, because the Caloric liberated passes off into the atmosphere, before a sufficient quantity of oxygen is admitted into the body of the grain, and before the union of what is admitted with the carbon of the seed can take place; consequently it quits the grain without the Carbonic acid, which should accompany it. The laying the grain thick, and covering it up, necessarily prevents the escape of the Caloric thus rapidly, and consequently its powers of agency are rendered available. The laying of the corn thick, and covering it up, is an indispensable remedy for an unavoidable evil, and when no better remedy can be devised; but it is better to prevent an evil, than to have to cure it, and the means of preven-

tion in this case I have already pointed out; let the steep water be at a temperature of 50 degrees, and the working floors at the same heat to receive it, and if it cannot be effected by natural means, then resort to artificial. In contrast to the effect produced by the coldness of the atmosphere, is an opposite result, produced by the too great warmth of atmospheric air in the working floors; for in consequence of the Caloric present, in such atmosphere, the Caloric liberated by the decomposition of water, &c. in the body of the grain, does not pass with such a rapid transition, from the grain to the atmosphere, and consequently acts in its capacity, as an agent, most effectually to produce a rapid growth.

But such rapidity of growth is always found injurious, inasmuch as the various changes which should take place, in the interior of the grain, do not go in unison one with the other. Too great an abstraction of Carbonic acid, and too small an impartation of oxygen, has taken place; the radicle is too much elongated, and is dead before the plumula has near reached its destined point. Under these circumstances, the Maltster finds that his grain has not acquired so large a quantity of Saccharum, as its quality, and a more favorable temperature of atmosphere, or system of management, would have enabled it to have obtained; and to prevent a loss of what is already procured, he finds himself under the necessity of causing vegetation totally to cease, by drying it on the kiln.

Similar to the effects which are produced by a very cold atmospheric temperature, are those produced by a strong and long continued current of air passing over the heap of grain; for although the temperature of such a body of air may be very suitable for the purposes of Malting; yet as the temperature of the grain will increase in proportion to the quantity of Caloric

liberated, by the process of decomposition, and most probably rise, until it becomes superior to the heat of the atmosphere, yet as soon as this occurs, an evolation of Caloric from the grain to the atmosphere consequently takes place, therefore the greater the quantity of air which passes over, the greater must be the escape of such Caloric; and such a rapidity of escape, depriving the grain of the assistant powers of Caloric, and being expended before germination is complete, a Malt of inferior quality is the product.

But let it not be imagined, from this description of the effects which sometimes are produced from a rapid and long continued current of air passing over the grain, that an admission of air, or even to cause a current of air to pass over the floors, is at all times injurious; for it is often found a salutary, and an indispensable measure to be adopted; but the time when it is needed, and the quantity requisite, are the points of consideration, and which call for the discriminating judgment of the Maltster; for as the Carbonic acid gas which is evolved from the grain is heavier than Atmospheric air, it often requires a current of air to dissipate it from the surface of the grain, and give room for a continued evolation; as also to afford pure air, for absorption by the grain, for the purpose of affording a fresh and continued supply of oxygen.

The time to remain in the couch having expired, and the grain having nipped, or the radicle having protruded through the skin, it is thrown from the couch to the floor, and is laid at a depth as circumstances dictate the most desirable, agreeable to the views and judgment of the Maltster.

From such period, until its arrival at the kiln, and to a state which, when it is necessary or desirable to arrest germination, and cause it to cease on the kiln, the best skill, judgment, and attention of the Maltster

to conduct it there in the most favorable condition, is absolutely necessary; and the several adages, "idleness makes the most work," and "a stitch in time saves nine," may with force and propriety be applied to a careless, idle, and ignorant Maltster, and a careful, industrious, and intelligent one; for while the former may be working continually at extremes, resorting to one evil to correct another, the latter may be quietly pursuing the "even tenor of his way," having taken a medium course from the beginning, and adhered thereto until the end.

If from unavoidable causes, or neglect, the root should advance too rapidly, and grow too long, it will then be best to break off the root, and let it sprout out again rather than let it continue its first course, run the created Saccharum to waste, and wither and die, before the process of germination is complete. Such a breaking off of the root operates upon grain, as cutting and pruning does upon young trees, which were running to waste, and expending the sap to promote a profitless growth. But it must be remembered, that it had been better that this evil had never existed, as its permission, and the application of the necessary remedy, has caused a great waste of Saccharum. In breaking off the root, care should be taken not to bruise or in any way damage the grain, and the same care should extend to the whole process, as bruising or cutting may destroy vitality, and cause a putrefactive fermentation to the injured grain.

By turning corn upon the floor with a shovel, much bruising and cutting consequently occurs, and also much injury, frequently, by too much chilling the corn.

Frequent raking and little turning is the best practice, and to rake twelve or more times a day sometimes is necessary, but no rule can be laid down how often it should be done; the judgment of the Malster must determine. The purport of turning is not only to advance the grain

gradually to the kiln, but also in conjunction with raking, to occasionally change the surface, so that each particle of grain may, in turn, be exposed to the air, for the purpose of its absorption; and also to allow the escape of the accumulated heat and Carbonic acid gas. The advantages of frequent raking, instead of seldom turning, are not only such as result from the promoting such absorption and extrication, by frequent change of surface; but also in consequence of such Caloric and Carbonic acid gas, which is extricated, being more frequently dissipated, by the agitation of the air, occasioned by the Maltster's movements in raking; and consequently admitting atmospheric air to its surface more frequently. As the purpose of the Maltster should be to promote the impartation of right principles, and in sufficient quantity, the extrication of such as are necessary to effect the required conversion, and to cause impartation and extrication to be carried on in unison in right time and right proportion; his maxim should be a steep at 50°, a couch at 50°, a floor at 50°, and an atmosphere within at 50°, and a right system of working to ensure it.

Having endeavoured thus far to point out the purport of malting, and what (appears to me) should be the right process to cause germination to commence, and go favorably on; the next subject for consideration is, how far it should be carried; under what circumstances the grain should be brought to the kiln, and then to close with the purport and method of drying it on the kiln.

I have already stated, (and it cannot be too frequently, until well impressed on the mind,) that the purport of malting is to convert a portion of the Fecula of the grain into Saccharum, and having so converted, to lose as little of it, as can be prevented; and I have pointed out the means of conversion and preservation, as far as relates to the growth of the root and acrospire in unison

and moderation; and the next question is, how far should the acrospire be allowed to grow, before the grain is thrown on the kiln, with the view entirely to stop it, &c. Some will say, until the back is three-fourths of the way up, others two thirds, and others one half: and herein all may be right, if the purpose of each is taken into consideration; but as relates to the Brewer, who malts for his own consumption, one half is better than any greater distance, provided he has accomplished the primary object, the conversion of as much Fecula into Saccharum, with the least attendant loss as is possible. For it is certainly of no use for him to create or convert, on purpose to lose; and his best judgment (or rather that of his maltster), is requisite, to enable him to perceive that nice point between gain and loss, so as to cease his endeavours to gain, as soon as the consequent loss exceeds it. By the law of Nature, he is prohibited from gaining all and losing none; the purpose of Nature is to convert Fecula into Saccharum, for the purpose of causing growth to the root and acrospire; but man converts for the ultimate purpose of converting Saccharum into Spirit, in the process of Brewing; and the more powerful purpose of Nature stands invincible in his way; and the best he can do, is to thwart and hinder her purpose, and gain his own as far as he is able.

A good practical Maltster, who knows nothing of theory, will tell you that, if he malts for a Brewer, he tries to get his corn mellow, without working much to root or back; which, to interpret into intelligible language to the theorist, means, that he tries to impart and abstract those principles which are necessary to convert as much Fecula into Saccharum as he can, without expending more of it as sustenance to the root and acrospire than he can help; and when his corn becomes what he calls mellow, (which is evinced if, by pressing

a few grains between the thumb and finger, they break free and chalky in appearance) then he conceives it fit to go on the kiln, for the purpose of stopping germination, evaporating from it the remaining moisture, and imparting the necessary color.

The nice adjustment of the process, so as to get the corn mellow and germination to cease at the same time, requires much care, attention, and skill; and as soon as such is effected, the process of evaporating the moisture left in the grain, cannot be resorted to too soon; for as the purport of the impartation of water to the grain in the cistern, and on the floor, is to supply it with the necessary aliment to cause and promote its growth, if such is not totally expended before germination ceases, it will prove the cause of putrefactive fermentation.

Should germination cease, before the corn is quite so mellow as the maltster could wish, he is frequently induced to endeavour to get rid of a portion of that water which has been imparted, (and the remaining portion of which is one of the causes of its not being mellow) by evaporation, before it goes on the kiln, which is effected by letting it lay in a thick heap, without turning, until it has become quite warm; the effect of which is to cause a much greater evaporation, than if it had been suffered to lay thin, and consequently cool.

Better than such a remedy had not been wanted; but if unavoidably needed, it is better to resort to it, to a moderate extent, than to throw it on the kiln before it is mellow.

In such a case, many imagine it is better to get rid of such water, by drying on the kiln, conceiving that the heat received on the kiln will produce the same effect as the internal heat generated, by laying thick on the floor. But such is not the fact; for in the latter

case, the heat necessary to evaporate the remaining water, is obtained by the decomposition of that water; and such decomposition causes an impartation and extrication of such principles as are necessary to complete the mellowness required; and in effecting such an object, care should be taken not to let the grain lay so as to get too hot, or to continue it out too long after germination has ceased, lest a putrefactive fermentation is produced.

The effect of applying an external heat on the kiln, let it be applied ever so moderately in the earliest stage, serves but to get rid of the water by evaporation, without decomposition; hence the required impartation and abstraction of such principles as are necessary to effect a completion of the mellowing process, is not made. The purport of what is called drying malt on the kiln, is three-fold:—To expel all the remaining moisture from the grain; to impart oxygen to it, at the same time; and to give it the required color.

To properly expel the moisture, the drying should commence with a small fire, and which should be gradually increased to the required intensity, as may be necessary to finish off with. The obvious purport of which is to avoid drying up the external coat, lest it should be rendered impervious to the passage of the water from the centre of the grain, in the form of vapour, to the atmosphere; and the access of oxygen from the decomposed air, to its internal parts.

The purport of imparting oxygen to the grain while on the kiln, is two-fold: to finish as far as possible the process of mellowing, and to impart the required color, and the usual method of drying is well adapted to effect it. The grain to be dried is laid at a convenient and proper thickness upon a perforated metal or tile floor, and the motive for perforation is for the impartation of oxygen, for the purposes named; if not so, a plain

solid floor would do as well, but practice has proved the superiority of the former to the latter; hence its general adoption. Beneath such floor, and at a suitable distance, is placed a fire of such fuel as will not, in combustion, yield any smoke, or, if any, the smoke of which will not impart any unpleasant flavor to the malt on the kiln. Stone coal, coke, and well dried wood, are the materials generally used as fuel.

Atmospheric air is the source and medium of supply of the required oxygen to the grain on the floor, and which also assists in carrying off the vapour expelled from it. A very considerable portion of atmospheric air is necessary to furnish oxygen, to carry on the combustion of the fuel, to generate and supply the required heat; another considerable portion, to supply oxygen to the grain on the kiln; and a third portion, to carry off the vapour expelled from it while drying. And practice has induced the fitting up the required furnace on right principles to effect it. A kiln furnace, properly fitted up, should consist of an iron frame fixed upon wheels, cast iron bars of suitable length, and at a proper height from the floor, placed horizontally, and at sufficient distance one from the other, furnished with a door to close that part of the furnace wherein the fuel is consumed; and another door to close both the ash-pit, and serving as a double door to the fuel-part of the furnace. On each side of the iron frame, on the outside of the fuel-part of the furnace, should be an opening, with a sliding damper to open or close at pleasure.

The purport of fixing the furnace on wheels, is to withdraw it from beneath the kiln floor, whenever occasion may require, such as the time when the malt is throwing off the kiln, when it is required to snap porter malt; and faggots are burnt for the purpose, which are placed on the floor of the ash-pit, &c. The motive for placing the furnace bars at a litte distance

from each other, is for the double purpose of allowing the ashes to pass through into the ash-pit, and atmospheric air to find access to the burning fuel between those bars, the oxygen of which is necessary to support its combustion. The furnace-door is usually left open, for the purpose of allowing a continual and rapid current of air to pass between the fire and the crown of the furnace; part of which air being decomposed, by the intense heat of the burning fuel, its oxygen is imparted to the malt on the kiln, whereby the process of mellowing is more or less completed, and the required color and flavor is also given. The furnace door is shut when needed, for the purpose of reviving the fire; as the current of air, which had been previously divided, part passing through the fuel, and part above, is, by shutting the door, directed with greater rapidity, and in larger quantity, through the fuel causing its more rapid combustion. The door which closes the ash-pit, and serves also as a double door to the furnace, may be shut, when it becomes requisite to damp the fire by the exclusion of air. The openings at each side of the furnace are for the purpose of allowing a current of air to pass through each, which, passing by the heated iron plates forming the sides of the furnace, receives from them heat, which dries and rarefies it, increasing its capacity and speed, to carry off the vapour as it rises from the grain on the kiln. The dampers to such openings, are for the purpose of regulating or excluding the admission of air.

It may be the opinion of many that the color and flavor imparted to malt on the kiln, is effected by heat alone; but such is not the case, although heat is the agent to effect the impartation, yet oxygen is the principle, which, being separated from atmospheric air by its decomposition effected by heat, combines with the grain by the power of affinity; and that such is the

fact, may be demonstrated by analogy. Blood derives its color, by the impartation of oxygen to it, in its passage through the vessels, contiguous to the lungs. Red lead is made by the addition of oxygen to common lead, which addition is effected by the agency of heat, which effects the decomposition of the atmospheric air, in contact with the lead, enabling the oxygen of the air to unite with it, by the power of affinity. Iron exposed to atmospheric air, at common temperatures, becomes coated with (what is termed) rust, which is an oxide of iron, the oxygen of the air uniting with a portion of the iron, and, together, forming a new compound substance. And beside these, many other instances of the change in color, effected by oxygen, might be adduced in proof.

The weight of barley malt, after it is dried, is from 36lbs. to 42lbs. per bushel, made from barley, which weighs from 48lbs. to 54lbs. per bushel, making a difference of about 12lbs per bushel. Allowing two gallons of malt as the increase per quarter, and calculating the weight of the malt dust, at one pound per bushel, the loss in weight will be about 10lbs. per bushel, which has been sustained by the conversion of barley into malt. To account for so great a loss in weight, I know of but two causes left; a little difference between the quantity of moisture held by barley, previous to its being steeped, and malt after it is dried on the kiln; and on the supposition that such difference amounted to 1lb. per bushel, there will be 9lbs. per bushel, still loss to account for, and in no other way does it appear to me possible to do it, than to assign it to an evolation of a portion of the ultimate principles of which the grain was originally composed, effected by the process of germination.

CHAP. II.

MALTING OF WHEAT, AND BREWING OF WHEAT MALT.

I am induced to include in one Chapter all the information which I am able to furnish, relative to the Malting of wheat, and the Brewing of wheat malt, for the purpose of concentrating the scanty portion which I possess, and placing it before the reader in a consecutive form.

The previous and subsequent Chapters have reference both to Barley malt, and Wheat malt; but the present Chapter to Wheat malt exclusively.

The very little and unsatisfactory experience which I possess, (and consequently can communicate to others) as relates to this subject, would deter me at present from furnishing even the little which I have obtained, did I not find that so many have gained less, and did I not also conceive the subject too important, and too little understood, to render the most trifling information valueless.

The very low price of wheat this last malting season, (1834 and 1835,) particularly as compared with the price of barley, and the probability of so great a comparative difference again occuring, invests the subject with an interest highly important to every Brewer, and has already awakened in the minds of many a desire to obtain a competent knowledge of it. There is no doubt, that many have this year made one step in advance

towards the accomplishment of their wishes. But knowledge is not to be obtained, without diligent and persevering research; and many who have thought lightly of the matter, have heedlessly and intemperately rushed foward to grasp their object; and because it has eluded them, they have as inconsistently and rashly withdrawn from the pursuit, concluding that it was but a mere phantom which flitted before them. That such was not the case; but, on the contrary, a real and substantial benefit, too valuable to be caught at one leap, I trust I shall be able to show.

First—Will wheat malt produce a better, or as good a beer as barley malt?—Second—Will it produce more extract?—Third—Which will produce most extract; white, or brown wheat?—Fourth—What is the average produce of either sort?—Fifth—What is the comparative value of barley, to either white or brown wheat, for the purpose of malting?—Sixth—What is the proper and best method of malting wheat, and brewing wheat malt?

These are so many questions, which must naturally occur to the mind of every reflecting Brewer; and I regret that I cannot answer every one of them, satisfactorily, both to the reader and myself. But, nevertheless, I will try my best.

To the first question, my reply is:—that as far as my experience goes, wheat malt will produce better beer than barley malt, provided it is malted and brewed on an approximation to right principles. I say approximation, because I have never yet seen any wheat malt which appeared to me to be made on *right* principles, consequently it could not be properly brewed. With the imperfect knowledge yet possessed, I have incompetently brewed wheat malt, which has appeared to me to have been improperly or incompletely made, yet on comparing its produce as beer with the produce of bar-

ley malt, I should give it the preference in point of flavor, as many others have done. But the chief difficulty which I have met with, (and to me the only *one remaining* of which I am aware) is, the brewing of it, so as to ensure transparency by the aid of Isinglass, in the space of twelve hours from the time of racking: namely, at the end of a week from the day of brewing. As relates to any ale from barley malt, I find no such difficulty at the end of a week; and in fact I have often, at a busy time, sent out, on Saturday, Ale, at 32lbs, and lesser densities, which was brewed on the preceding Tuesday, and which has been tapped and partly consumed the next day, perfectly bright.

Brewing and fermenting wheat malt on the same system as barley malt, I find will not produce a similar result, as relates to transparency, twelve hours being sufficient to effect it on Ale brewed from barley malt, and seventy-two to produce the same result on Ale from wheat malt; hence it is obvious that the malting of wheat requires a different process from that which has been adopted, in making such as I have brewed, in order to render the same system of brewing adequate to produce the same results; or else, that a different system of brewing it should be adopted, suitable to the difference in the properties of each. The effect being known and experienced, it becomes necessary to endeavour to discover the cause, with a view to the adoption of a suitable remedy. The best method of procedure, I think, is to compare the results of an analysis of barley, against those of a similar process on wheat; and though fully aware, that the accuracy of any statement cannot be relied on, as applied to every description of barley or wheat, yet such as below is furnished, will, I conceive, enable us to trace the cause, why Ale produced from wheat malt, will not become transparent so early as Ale from barley malt. From what author I obtained

the statement of the analysis of barley I forget; but the statements relative to the analysis of wheat, are such as are stated to have been furnished by Sir Humphrey Davy; one applying to wheat before ripe, and the other after; but what species of wheat is not stated:—

Barley.		Unripe Wheat.		Ripe Wheat.	
Gum - -	5	Gluten -	24	Gluten -	19
Sugar -	4	Starch -	70	Starch -	77
Gluten -	3	Not stated	6	Not stated	4
Starch -	88				
	100		100		100

From these statements, the important conclusion may be drawn, that wheat possesses much more gluten than barley; and unripe wheat more than ripe; and I believe that not only wheat, but all grain possesses more gluten in its unripe than in its ripe state, and also brown wheat more than white; and that the difference in the produce of malt, made from what is termed steely and free barley, is owing to the presence of a greater quantity of gluten in the former, than in the latter.

On reference to the comparative statement of the analysis of barley-malt against that of barley as given in page 35, chap. 1st, it will be found that by the conversion of barley into malt, the quantity of gluten contained in the barley is reduced from three parts to one, in its conversion into malt.

If right in my conjecture, that Ale produced from wheat malt, brewed on the same system as barley malt, does not become transparent so early as Ale produced from barley malt, in consequence of wheat malt possessing much more gluten than barley malt; the obvious conclusion is, that to produce an equal effect, it is necessary either to adopt such a system of malting as will reduce the quantity of gluten, in each sort of malt, to the same amount; or, if such is impossible, or has not

been done, then to endeavour to abstract the superfluous quantity of gluten, obtained by solution in the brewing of wheat malt, after it is extracted from the malt.

What should be the system of malting to accomplish this object, I am not prepared to say; my own practical experience is much too limited, to enable me to speak with any degree of confidence on the subject, and I can only venture to give a theoretical opinion.

That the substance called gluten, is, in germination, decomposed, and its carbon uniting with oxygen is abstracted, and becomes a component principle of a new compound, called carbonic acid gas, appears to me quite evident: and knowing that wheat malt possesses more gluten than barley, the natural inference which it appears to me, should be drawn therefrom, is, that as there is more work to be done, more time and precaution are necessary to effect the diminution of the gluten in wheat than in barley, by the process of malting.

Practical observation, confirmed by theoretical investigation, has convinced me that the malting process of wheat should be much cooler, slower, and more protracted, than the malting of barley; that the first steep should be for a shorter period, and that sprinkling on the floor should be resorted to, as early as practicable, and as often as required.

That the grain should be worked thin and cool upon the floor, yet not cold. That every available facility to the impartation of oxygen, and the dissipation of the carbonic acid gas resulting, should be supplied. That the root and acrospire should be checked in its growth, without being stopped, and that vegetative life should be preserved as long as possible, to afford time for the diminution of the gluten, and the increase of saccharum.

Should a Brewer find it impracticable to reduce the

quantity of gluten in wheat, by any system of malting, to the same, or any where near the same amount, as in barley malt, it then becomes necessary that he should endeavour to reduce it in the process of brewing; and it appears to me that there are two methods best calculated to effect it :—by long boiling, or by an extended fermentation. If it was possible, by any process of extracting the soluble materials of wheat malt, to obtain all such as was desirable, and leave behind the superfluous quantity of gluten, such a mode would be preferable to either long boiling or an extended fermentation; but knowing of no such method, and conceiving that none is likely to be known, I can only recommend such as appears to me the best calculated to effect it.

To an extended fermentation, there is the strong objection, that in seeking for early transparency, it must be obtained by a sacrifice of fulness and flavor, which will prove an evil that will more than counterbalance the advantage; the only method left, therefore, appears to me to be by longer boiling.

Whoever has paid due attention to the subject, must know, that the extract of malt, called wort, is transferred from the under back to the copper, an homogeneous fluid; but that, as boiling commences and continues, its decomposition begins and progresses, proportionately, to the rapidity of ebullition, and the time of its continuance. If wort is occasionally examined in a glass while it is boiling, small particles will be found floating therein, which upon each observation are found to increase in magnitude, until they have attained to a maximum size, beyond which they increase in number. These flakes are coagulated gluten; and the longer a wort is boiled, the greater will be the quantity of gluten coagulated.

There are two motives for the boiling of wort, (although not many Brewers are fully aware of more than

oney, to coagulate a portion of the gluten extracted from the malt, and to obtain a sufficient quantity of extract from the hops boiled with it.

It is a usual practice with Brewers to boil the second wort longer than the first, and the motive (known or not known) is, that the second wort, containing more gluten than the first, needs longer boiling to separate it by coagulation. And the reason why the second wort contains more than the first, is because the gluten is not so soluble as the Saccharum, and fecula; and that which is most soluble is first extracted.

In the Chapters on boiling and fermentation, I shall enter more fully into the subject.

If therefore Wheat malt contains more gluten than barley malt, the wort therefrom will also contain more; and if the difference in quantity is not abstracted by coagulation, then there must be more left to be got rid of by fermentation. And if the Brewer abstains from getting rid of it by fermentation, lest he should lose the desirable fulness and flavor, which his customers require, then he must expect it to remain, as a preventive of early transparency.

In boiling the wort of wheat malt, a longer period than the wort of barley malt, for the purpose of coagulation, care should be taken not to boil the hops too long, lest the terrene bitter should be extracted. They may be put into the copper at any period, before the time allowed for boiling expires, as the judgment dictates. But more on this subject will be found in the 8th Chapter on Hops.

As long boiling wastes both time and fuel, there is a powerful inducement to save both, by an adoption of the best system that can be devised in the malting of wheat, with a view to the diminution of the gluten in the malt house, rather than in the copper, and the latter should only be resorted to as a remedial mea-

sure, in case it could not be, or has not been, effected in the former. Another powerful motive to an endeavour to effect this object in the malt house, rather than in the copper, is, because in the latter the gluten coagulated is of no value, but in the malt house it may be converted into the valuable materials of Fecula and Saccharum.

I have before stated, that brown wheat contains more gluten than white wheat; and I have next to state, that as far as my own experience goes, the average produce of white wheat malt is about 12lbs. more in density per quarter of malt, than can be obtained from brown wheat malt. And as the general difference in price between white and brown is in no way equal to the value of the extra produce, and as the produce contains less gluten, there is a double motive for giving it the preference.

Having pointed out the sole unremoved difficulty which I have met with in the brewing of Ale from wheat malt, equal in quality in every respect to such as I have produced from barley malt, and having given theoretical views of what should be the means used to obviate it, I will next proceed to answer the second question. Will it produce more extract?

The best reply which I conceive I can give, will be found in the following memorandums relative to a wetting of wheat, and a wetting of barley.

On the 25th December, 1833, wet 19 quarters, 7½ bushels of wheat, which was bought for 20 quarters, imperial measure. The wheat was imported from Dorsetshire, and weighed 65lbs. per bushel. The principal part was white, with a small quantity of brown mixed with it. It was very dry and swelled very much in the cistern; it lay in steep 54 hours; nipped early; was worked all through in mild wet weather; worked thin on the floor; raked very much in its early stage, instead

of much turning; dried in halves; first thrown on the kiln, January 10th, 1834, E. 7: thrown off kiln, January 11th, E. 11½.; 28½ hours in drying. The other half was then thrown on, and came off January 13th; in couch and on the floor 14 days; came very mellow to the kiln, but considerably moulded; thrown off the kiln in a heap by itself. Laid to cool and mellow till January 27th, and 31st, 1834, and was then screened and measured up. Quantity of wheat malt, 21 quarters, 2½ bushels, weighing 47½lbs per bushel. Quantity of malt dust, 2 bushels 1½ gallon, weighing 50lbs.

January 29th, 1834; brewed 10 quarters of the wheat malt, mixed with 10 quarters of barley malt, of the season, 1832-3, which weighed 40½lbs per bushel.

Produce in Raw Wort:—

	lbs. ths.		lbs. ths.
First wort, 31 barrels,	at 35 6	per barrel is	1103 6
Second do. 27 do.	at 28 3	do. is	764 1
Third do. 27 do.	at 10 5	do. is	283 5
Fourth do 28½ do.	at 2 1	do. is	59 8
			lbs ths.
Divide by quarters of malt			20)2211 0(110 5

Produce in boiled and return Wort:—

	lbs ths.		lbs. ths.
56 Barrels of XX Ale	at 31 8	per bl. is	1780 8
9½ do. of Table beer,	at 13 5	ditto, is	128 2
28½ do. of return wort	at 3 0	ditto, is	85 5
			lbs. ths.
Divide by quarters of malt			20)1994 5(99 7½ pr q

	Raw ext.	Boiled ext.
Extract of wheat and barley malt (mixed) per quar.	110 5	99 7½
which multiply by quarters of malt ..	20	20
	2210,0	1994,5
Deduct from which, the produce of 10 quar. of Barley malt, at 97 lbs. per quar., in raw extract, and 88lbs per quar. in boiled extract, which was found to be the average extract of such malt, in previous brewings.	970,0	880,0
Divide such residue by the 10 qs. of wht mt.	10)1240,0	1114,5
which leaves the produce of the wt.mt. pr. qr.	124	111,4½

To ascertain the quantity of extract obtainable, as per quarter of wheat, agreeable to the above product, as malt—

Multiply 111 4½
by 21 quars. 2½ bus.

which divide by 20qrs wheat 20)2375, 8(118lbs. 7½ tenths extract per quarter of wheat.

The XX Ale from the above brewing was attenuated to 11lbs. 5ths. per barrel. February 7th, 1834, distilled three quarts of it, which yielded 12 (liquid) ounces (20 ounces to an Imperial pint) of Spirit, at 5.5 per Cent, over proof; equal to 10gs. 2qts. 0½pt. per 100 gallons at proof.

By calculation it will be found that, at the computed rate of production by distillers and the Excise, (one gallon of proof spirit for every 5lbs. of attenuation) the product should have been at the rate of 11 gallons of Spirit, per 100 gallons of Ale; and allowing for waste and inaccuracy, it most likely was so.

From distillations of XX Ale from barley malt, free from any acetous acid, I have invariably found the product correspond with that realised from XX Ale, brewed from wheat and barley malt, mixed; and I am satisfied that the prevailing opinion which exists, that beer brewed from wheat malt is more intoxicating than that which is brewed from barley malt, is not correct; provided the beer brewed from each is of the same density, and attenuated to the same extent; but is perfectly correct, as relates to an equal length, drawn from an equal quantity of each malt; for as the wheat malt yields the most extract, it consequently yields the most spirit.

The brewing as above was for running guile Ale, and the remaining quantity of wheat malt for Store beer, the extract from the latter being by the same mode of computation, about 2lbs. per quarter less, which differ-

ence may be accounted for by the greater extent of coagulation consequent on longer boiling, and loss by absorption of hops, consequent on the use of a much larger quantity.

I must next request the attention of the reader to the following memorandums relative to the particulars of a wetting of barley, as a contrast to the wetting of wheat.

January 14th, 1834, measured into the cistern, 19 quarters, 7½ bushels of barley, from Poole, Dorsetshire, weighing 54lbs. per bushel. Skimmed the Cistern, produce about a bushel; M.9 steeped; remained in steep 60 hours; first kiln thrown on February 1st. 1834.

February 24th, 1834, the whole of the malt from the above was screened and measured up; and the produce in malt was 19 quarters, 6½ bushels, which, with the bushel of skimmings, was just equal to the wetting.

An imperial bushel of the malt weighed 41½lbs. There was 6½ bushels of malt dust therefrom, weighing 134lbs.

March 5th, 1834, brewed the above malt, made up to 20 quarters from a heap of new malt of about the same quality.

Produce in Raw Wort:—

			lbs.	ths.			lbs.	ths.
First Wort 26 barrels		at	33	3	per bar.	is	865	8
Second do. 28	do.	at	27	4	do.	is	767	2
Third do. 26	do.	at	9	2½	do.	is	240	5
Fourth do. 32	do.	at	4	0	do.	is	128	0

Divide by quarters of malt - - 20)2001 5(100 7½ lbs.ths.

Produce in Boiled and Return Wort:—

Bs.Fs.Gs.		lbs.ths.			lbs.	ths.
41 0 0	of XX Ale, at	33 7	per Bar.	is	1381	7
18 2 0	of Table Beer, at	12 3	do.	is	227	5
32 0 0	of Return Wort,	4 6½	do.	is	148	8

which divide by 20 quarters of malt 20)1758 0(87 9 lbs. ths

To ascertain the quantity of extract obtainable, as per quarter of barley, agreeable to the above product as Malt:—

	lbs. ths.	
Multiply	87 9	
by	19	qrs. 6½ bush. of malt.
Divide by qrs. of barley	20)1741 5	(87lbs. ext. per quarter of barley.

The half bushel short in the steeping of barley was made purposely to correspond with the deficiency in wheat.

Swan's Saccharometer, made by Mr. Joseph Long, No. 20, Little Tower Street, London, the same in principle and results as the Saccharometer made by Messrs. Dring and Fage, Tooley Street, London, was the instrument used on each occasion; and to which applies every reference as to density that has been and will be made in the previous and subsequent pages. In furnishing these two examples, for the purpose of showing the difference in the produce of wheat malt, and barley malt, it must not be for one moment thought that they are given as a proof of standard difference, or as a proof of the average amount of extract, obtainable from either sort; for on reference to the weight of both, it will be found much above an average of years.

The third question I have already answered, by the statement, that in practice I have found that white wheat, converted into malt, yields a greater and better extract than brown.

To the fourth question, "What is the average produce of either sort?" my reply is, that the average produce, in my own practice, has been on wheat malt, brewed in three different years; and on barley malt, brewed in the last four successive years, as follows:—white wheat malt about 108lbs. per qr.; brown wheat malt about 96lbs. per qr.; and barley malt about 85lbs. per qr.

To the fifth question, as relates to the comparative value of barley malt, to white wheat malt, and brown wheat malt, I must refer to the preceding observations relative to the quality of the extract from each; and have now to offer a few remarks, on the comparative value of each, as relates to the quantity of extract obtainable. If there was no duty on malt, or the duty was charged on all grain steeped, at one amount, in its dry state, previous to wetting, deducting for skimmings, there would be one difficulty less in the way of making an accurate calculation.

But as the case stands, we must be content to take the experience of an average of years, to arrive at the average difference in the amount of duty paid on wheat malt, and barley malt; and by adding that difference to the legal duty of 20s. 8d. per quarter, we come at the legal charge of duty payable on wheat malt. This I have done, and find the average difference of duty paid between each sort, in three years, was 2s. 8d. per quarter, which added to 20s. 8d. the legal duty, will make the comparative duty on barley malt, 20s. 8d. and on wheat malt, 23s. 4d. And by taking such an amount, should it be above the experience of others, they can on reference to the annexed Tables, make such deductions as they think proper. The average increase in making may be fairly stated :—white wheat 5 gallons per quarter, brown wheat 4 gallons per quarter, barley 2 gallons per quarter.

Having furnished the most correct information which I am able, for the purpose of affording materials for the basis of calculation in constructing the following Tables, and cautioning the reader not to rely on them as accurate, but an approximation to accuracy; I next proceed to show the purport of, and the method of procedure in, their construction.

The purport of No. 1, 2 and 3 Tables, are to show

the relative value of white wheat malt, against brown wheat malt, or barley malt, or either sort, against the other; and are constructed without reference to duty, on the supposition that such Tables may be of service to British Brewers, at some future period, should the duty on malt be removed; or immediately so to the Foreign Brewer, who may not be subject to the payment of duty.

The purport of No. 4, 5 and 6 Tables, are to show the relative value, with the duty charged on each.

On the data furnished, the quantity of extract obtainable from a quarter of each sort of wheat and barley, manufactured into malt, including the increase, will stand about as follows:—

White wheat	116lbs	per quarter
Brown ditto	102	ditto
Barley ditto	88	ditto

Taking the lowest price of white wheat at 40s. per quarter, brown wheat at 35s. and barley at 20s. per quarter, and adding 4s. per quarter to each price, as the expense of conversion into malt, for the first set of of Tables; and adding to such amounts the respective duties on each, for the second set of Tables, we have as the basis of computation

	White wheat.			Brown wheat.			Barley.		
	£	s.	d.	£	s.	d.	£	s.	d.
Cost per quarter	2	0	0	1	15	0	1	0	0
Expense making	0	4	0	0	4	0	0	4	0
	2	4	0	1	19	0	1	4	0
Duty	1	3	4	1	3	4	1	0	8
	3	7	4	3	2	4	2	4	8

The next process is to ascertain the cost of 100lbs. extract from each sort of malt, calculating on the average produce, and cost of one quarter of each, including the increase, as above.

	£ s d	White Wheat.		£ s d
If 116lbs. cost	2 4 0	what will 100lbs. cost?	ans.	1 17 11
If 116lbs. do.	3 7 4	do. do. 100lbs. do.?	ans.	2 18 0½
	£ s d	**Brown Wheat.**		**£ s d**
If 102lbs. cost	1 19 4	what will 100lbs cost?	ans.	1 18 2¾
If 102lbs. do.	3 2 4	do. do. 100lbs. do.?	ans.	3 1 1¼
	£ s d	**Barley.**		**£ s d**
If 88lbs. cost	1 4 0	what will 100lbs. cost?	ans.	1 7 3¼
If 88lbs. cost	2 4 8	do. do. 100lbs. do.?	ans.	2 10 9

The following Tables appear to me so plain and obviously simple as to require no explanation, and although not to be depended upon, as furnishing such results as may be by every, or any person, invariably realised; yet are well calculated, I trust, to afford the means of judging which species of grain is most profitable to purchase as relates to quantity of produce, agreeable to the market price of each.

One example may serve to show their use. The prices of white and brown wheat and barley, in the market, may be 45s. 40s. and 35s. and the brewer is desirous to know which will afford him the most profit as relates to the quantity of produce of each, in order that he may be governed in making his purchase for the purpose of converting either sort into malt. If no duty is payable on malt, he must refer to the first columns of each Table, No. 1, 2 and 3, and find the several prices named and against each he will find, in the third columns, the several costs of 100lbs. density of extract from each, to be 42s. 2¾d. 43s. 1½d. 44s. 3¾d.

But if malt is subject to a duty in ratio of the amount calculated, he must then refer to the first columns of the several Tables, No. 4, 5 and 6, for the prices of each sort of grain, and against each, in the third columns, he will find the several costs of 100lbs. density of extract from each, to be 62s. 4½d. 66s. and 67s. 9½d.

TABLES WITHOUT DUTY.

No. 1. WHITE WHEAT. Cost of Wheat per quarter	Cost of Wheat Malt per quarter	Cost of 100lbs density of extract	No. 2. BROWN WHEAT. Cost of Wheat per quarter	Cost of Wheat Malt per quarter	Cost of 100lbs. density of extract	No. 3. BARLEY. Cost of Barley per quarter	Cost of Barley Malt per quarter	Cost of 100lbs. density of extract
s.	s.	s. d.	s.	s.	s. d.	s.	s.	s. d.
40	44	37 11	35	39	38 2¾	20	24	27 3½
41	45	38 9½	36	40	39 2½	21	25	28 4¾
42	46	39 7¾	37	41	40 2¼	22	26	29 6½
43	47	40 6	38	42	41 2	23	27	30 8
44	48	41 4½	39	43	42 1¾	24	28	31 9¾
45	49	42 2¾	40	44	43 1½	25	29	32 11¼
46	50	43 1	41	45	44 1¼	26	30	34 1
47	51	43 11½	42	46	45 1	27	31	35 2¾
48	52	44 9¾	43	47	46 0¾	28	32	36 4¼
49	53	45 8¼	44	48	47 0½	29	33	37 6
50	54	46 6½	45	49	48 0¼	30	34	38 7½
51	55	47 4¾	46	50	49	31	35	39 9¼
52	56	48 3¼	47	51	50	32	36	40 10¾
53	57	49 1½	48	52	50 11¾	33	37	42 0½
54	58	50	49	53	51 11½	34	38	43 2
55	59	50 10¼	50	54	52 11¼	35	39	44 3¾
56	60	51 8½	51	55	53 11	36	40	45 5¼
57	61	52 7	52	56	54 10¾	37	41	46 7
58	62	53 5¼	53	57	55 10½	38	42	47 8½
59	63	54 3½	54	58	56 10¼	39	43	48 10¼
60	64	55 2	55	59	57 10	40	44	50
61	65	56 0¼	56	60	58 9¾	41	45	51 1½
62	66	56 10¾	57	61	59 9½	42	46	52 3¼
63	67	57 9	58	62	60 9¼	43	47	53 4¾
64	68	58 7¼	59	63	61 9	44	48	54 6½
65	69	59 5¾	60	64	62 8¾	45	49	55 8
66	70	60 4	61	65	63 8½	46	50	56 9¾
67	71	61 2¼	62	66	64 8¼	47	51	57 11¼
68	72	62 0¾	63	67	65 8	48	52	59 1
69	73	62 11	64	68	66 8	49	53	60 2½
70	74	63 9½	65	69	67 7¾	50	54	61 4¼
71	75	64 7¾	66	70	68 7½	51	55	62 6
72	76	65 6	67	71	69 7¼	52	56	63 7½
73	77	66 4½	68	72	70 7	53	57	64 9¼
74	78	67 2¾	69	73	71 6¾	54	58	65 10¾
75	79	68 1	70	74	72 6½	55	59	67 0½
76	80	68 11½	71	75	73 6¼	56	60	68 2
77	81	69 9¾	72	76	74 6	57	61	69 3¾
78	82	70 8¼	73	77	75 5¾	58	62	70 5¼
79	83	71 6½	74	78	76 5½	59	63	71 7
80	84	72 4¾	75	79	77 5¼	60	64	72 8½

TABLES WITH DUTY.

No. 4. WHITE WHEAT.

Cost of Wheat per quarter	Cost of Wheat Malt per quarter		Cost of 100lbs density of extract	
s.	s.	d.	s.	d.
40	67	4	58	0½
41	68	4	58	10¾
42	69	4	59	9
43	70	4	60	7½
44	71	4	61	5½
45	72	4	62	4¼
46	73	4	63	2½
47	74	4	64	0¾
48	75	4	64	11¼
49	76	4	65	9½
50	77	4	66	8
51	78	4	67	6¼
52	79	4	68	4½
53	80	4	69	3
54	81	4	70	1¼
55	82	4	70	11½
56	83	4	71	10
57	84	4	72	8½
58	85	4	73	6¾
59	86	4	74	5
60	87	4	75	3¼
61	88	4	76	1½
62	89	4	77	
63	90	4	77	10¼
64	91	4	78	8¾
65	92	4	79	7
66	93	4	80	5½
67	94	4	81	3¾
68	95	4	82	2
69	96	4	83	0½
70	97	4	83	10¾
71	98	4	84	9
72	99	4	85	7½
73	100	4	86	5¾
74	101	4	87	4¼
75	102	4	88	2½
76	103	4	89	0¾
77	104	4	89	11
78	105	4	90	9½
79	106	4	91	8
80	107	4	92	6¼

No. 5. BROWN WHEAT.

Cost of Wheat per quarter	Cost of Wheat Malt per quarter		Cost of 100lbs density of extract	
s.	s.	d.	s.	d.
35	62	4	61	1¼
36	63	4	62	1
37	64	4	63	0¾
38	65	4	64	0½
39	66	4	65	0¼
40	67	4	66	
41	68	4	66	11¾
42	69	4	67	11½
43	70	4	68	11¼
44	71	4	69	11
45	72	4	70	10¾
46	73	4	71	10½
47	74	4	72	10½
48	75	4	73	10¼
49	76	4	74	10
50	77	4	75	9¾
51	78	4	76	9½
52	79	4	77	9¼
53	80	4	78	9
54	81	4	79	9[illegible]
55	82	4	80	8½
56	83	4	81	8¼
57	84	4	82	8
58	85	4	83	7¾
59	86	4	84	7½
60	87	4	85	7¼
61	88	4	86	7
62	89	4	87	6¾
63	90	4	88	6½
64	91	4	89	6½
65	92	4	90	6¼
66	93	4	91	6
67	94	4	92	5¾
68	95	4	93	5½
69	96	4	94	5¼
70	97	4	95	5
71	98	4	96	4¾
72	99	4	97	4½
73	100	4	98	4¼
74	101	4	99	4
75	102	4	100	3¾

No. 6. BARLEY.

Cost of Barley per quarter	Cost of Barley Malt per quarter		Cost of 100lbs. density of extract	
s.	s.	d.	s.	d.
20	44	8	50	9
21	45	8	51	10½
22	46	8	53	0¼
23	47	8	54	2
24	48	8	55	3½
25	49	8	56	5¼
26	50	8	57	6¾
27	51	8	58	8½
28	52	8	59	10
29	53	8	60	11¾
30	54	8	62	1¼
31	55	8	63	3
32	56	8	64	4½
33	57	8	65	6¼
34	58	8	66	8
35	59	8	67	9½
36	60	8	68	11¼
37	61	8	70	0¾
38	62	8	71	2½
39	63	8	72	4
40	64	8	73	5¾
41	65	8	74	7¼
42	66	8	75	9
43	67	8	76	10½
44	68	8	78	0¼
45	69	8	79	2
46	70	8	80	3½
47	71	8	81	5¼
48	72	8	82	6¾
49	73	8	83	8½
50	74	8	84	10
51	75	8	85	11¾
52	76	8	87	1¼
53	77	8	88	3
54	78	8	89	4½
55	79	8	90	6¼
56	80	8	91	8
57	81	8	92	9½
58	82	8	93	11¼
59	83	8	95	0¾
60	84	8	96	2½

Whatever may be the indications of the Tables, as relates to the comparative value of each sort of grain for the purpose of Malting and Brewing, bearing in mind the data on which they are calculated, the Brewer should take into consideration, the relative quality of each species of grain that may be offered him; the knowledge acquired by his Maltster, of the process of malting each; and his own, as to the brewing of either sort of malt, he may make; and draw such conclusions from their indications as best suit his views.

We next come to the sixth and last question proposed. "What is the proper and best method of malting wheat, and brewing wheat malt?"

As relates to the proper and best method of malting wheat, I have stated my inability to furnish any satisfactory practical information, for want of sufficient experience, and have stated my theoretical views of the subject, and repetition must be unnecessary.

I feel quite incompetent also to give conclusive and satisfactory practical information relative to the brewing of wheat malt, either in a state of admixture with barley malt, or alone, on the same grounds; but as such as I can give on a subject so little understood may prove serviceable to others, I am prompted to furnish it.

I have before stated that wheat possesses more gluten than barley, and such being the case, if its reduction in the process of malting is not effected, so as to leave the amount possessed by wheat malt, the same as by barley malt, the process of first mashing proves more difficult, and the goods more likely to set, in proportion to the difference in quantity of gluten possessed by the former above the latter.

Wheat malt being heavier than barley malt, yet the husk thinner and lighter, it lays closer together in the mash tun, and its several parts are less accessible, by

the mashing menstruum; it becomes therefore necessary to adopt precautionary measures to prevent the setting of the goods, whether wheat malt is brewed alone, mixed with barley malt, or any other substance.

I have brewed wheat malt with barley malt, in the proportions of one-fourth, one-third and one-half of wheat malt; with coarse bran in varied proportions; and without the admixture of any other substance; and have never experienced any difficulty in getting the wort from the goods, although I have heard others say that they have met with much difficulty, when they have only used a small quantity of wheat malt mixed with barley malt. And I conceive myself indebted for the invariable success I have experienced in brewing it under every circumstance, to the choice of a right first mashing heat, as enabled, by the arithmetical mode of calculating it, as detailed in the 5th. Chapter, under the head of "First mashing heat."

I have never met with any difficulty in brewing wheat malt, ground with stones, but prefer its being crushed between rollers.

I have pursued the same system of brewing wheat malt, in a mixed or unmixed state, as barley malt, agreeable to the method detailed in the succeeding Chapters, with the exception of boiling the worts longer, and pitching the tun with less yeast. The extra time of boiling, and the difference in the quantity of yeast, cannot be subject to any rule, but must be decided by the Brewer's judgment.

CHAP. III.

THE QUALITY AND STATE OF MALT FOR BREWING.

Having in the first chapter "on Malting," endeavoured to impart some useful information to Brewers who make malt for their own consumption, it appears to me, that a few hints to those who purchase malt, either from choice or necessity may be acceptable, and to which a separate Chapter may, with propriety, be devoted.

As a general rule, I conceive that the Brewer, who is a purchaser of malt for his own brewing, is labouring under several disadvantages to which the Brewer, making for his own consumption, is not subject.

But as an exception to that Rule, if a Brewer has not a sufficient knowledge of the process of malting, as to be enabled to judge whether or not the maltster he employs is able or willing to make him good malt, or cannot really engage a man who is able or willing, then he may probably purchase to more advantage, than he can manufacture for himself; or should he not be able to make sufficient for his annual consumption, during the proper malting season, it will be better for him to obtain, by purchase, the extra quantity he needs, of such malt, as has been properly malted in the right season, rather than commence malting before the grain is in a fit state, or continue after the weather has become too warm, for the sake of saving the difference in the price, at which

he can make and purchase at; because he will find that malt thus purchased, will most probably yield as much more, and as much better produce, as will compensate for the difference in the cost.

A Brewer who makes malt for his own consumption, has an eye to the quality and quantity of the product in the mash tun. But the Maltster who makes malt for sale, has a view to the product by measure.

The former works his grain cool, steady, and short; the latter, warm, hastily, and the back to the extreme. The former dries his grain slow, gradual, and home; and pale, or amber, or a point between, as his Trade requires; the latter quick, and therefore dry without, and raw within, nor forgets to bleach and sprinkle to improve both appearances and measure.

The former screens his barley, and extracts the light grains, &c. before he wets, or skims his cistern well; the latter takes no such pains and trouble.

The former buys the choicest barleys; the latter is not so nice or scrupulous.

If the former cannot purchase well at home, as relates to price and quality, he frequently imports from distant Counties; the latter seldom or ever does.

The Brewer who buys his grain well and converts it into good malt, saves not only the difference in price, between its cost and what he can purchase it at of a Maltster, but he commands a malt of such a quality, as he cannot purchase at any price; and on which no well disguised trickery may have been played.

These observations apply well to pale malt, but with peculiar force and propriety to blown brown malt, manufactured for home use or sale.

In one season upon premises belonging to a Brewer, I have known the average increase on the pale malt, made during the season, was two gallons per quarter, and the average increase upon blown brown malt, at

three bushels two gallons per quarter, and both made with a view to the best profit, in the mash tun. What would have been the difference, if such had been made for sale ?

The average cost of the pale malt per quarter, was 55s. 3¼d. and the average cost of the brown, from the same barley, was 41s. 9d. per quarter.

The brewer who makes his own malt can, whenever it may be requisite, pass his malt over the kiln, for the purpose of freshening it, in case it is become slack, or giving it more color, in case his Maltster may have failed to give it sufficient; but the purchaser only of malt, might not be able, or without much inconvenience and expence, be able to effect such salutary operations.

In the Spring and Summer months, when fermentations are difficult to control and check, and when beer cannot with facility be furnished to the Public in a clean and perfectly transparent state, the passing of the malt over the kiln, and the addition of as much colour to pale malt, as will place it in a medium state, between pale and amber, will assist the Brewer most materially and beneficially, in effecting so desirable an object.

A brewer who makes his own malt, can cause a change of the steep water, as often as may be requisite, to deprive barley of that fœtid oleaginous substance, residing in the external skin, and with which the steep water is so abundantly impregnated, which is evidenced by the change in color, and the unpleasant odour; and thereby avoid an impartation of it, to the wort in brewing; but as a Maltster for sale is perhaps not aware of the liability of impartation, or may be regardless of it, (as his malt would not be improved in its appearance thereby, consequently would not sell the better for it,) he, therefore, will not submit to the consequent labour.

The Brewer then, who is a purchaser of such malt, stands not upon an equal footing with the Brewer who makes his own and adopts the best system of malting.

It is this empyreumatic oil which gives to grain spirit its unpleasant smell, when the Distiller's grist is composed of a large portion of unmalted barley, and forms the strong characteristics of Feints, which is the last produce of spirit in distillation.

The Brewer who manufactures his own malt, may appropriate his first and latter wettings, or any intermediate wettings, which may not prove satisfactory, to the manufacture of amber, or blown brown malt, but which in some Counties is never done by the Maltster who makes for Sale, consequently, the purchasing Brewer obtains that species of malt, for ale brewing, which the other avoids; and whether or not a Brewer brews Porter, he can always ensure a sale of it, and probably to a greater advantage than brewing it.

It is well known by those who are conversant with malting, that the first few wettings of barley do not, as a general rule, produce malt of as good quality, as such wettings which are in work, when (what is called) "the House is in good working order." Again, severe or excessively mild weather, or some other untoward circumstance, may, in the course of the season, cause a wetting to come to the kiln in bad condition, and the Brewer who purchases a stock of barley, to make malt equal to the year's consumption, is often overtaken by warm and unseasonable weather, previous to the termination of his malting operations, and in such case he finds it advantageous to dry off, for brown malt, instead of pale,

A Brewer who makes his own malt, purchases his

barley, and manufactures it into malt, at the same time the Maltster does, who makes it for sale. The latter makes it for a natural and reasonable profit, and often obtains an unnatural and unreasonable profit, at a time when malt experiences an advance in price, resulting from some adventitious cause. The purchasing Brewer pays both the reasonable and unreasonable profit.

BREWING.

CHAP. IV.

GRINDING OR CRUSHING.

Much diversity of opinion prevails relative to the best mode of preparing the malt for infusion in the mash tun. Some believe it is best to pass malt through rollers, which, by pressure, break the skin, and flattening the grain, and destroying the attraction of cohesion, among its parts, presents a large, yet connected surface of soluble particles to the menstruum administered. Others imagine that grinding is preferable, but yet differ in their opinions as to the requisite degree of fineness in grinding.

Such opinions remind me of the tale of the Travellers and Camelion; and part of the same reply may with propriety be given, "you all are right, and all are wrong," for a diversity of circumstances, occasionally render each mode the most desirable; and I am of opinion, that no Brewer should be without stones to grind, and rollers to crush, in order to use either, as circumstances may require.

But as a preliminary step to the attainment of an experience, sufficient to direct the judgment, it is necessary to take a view of the different qualities and state of malt, which come under the Brewer's operations.

The Brewer's object is to extract by solution, and

separate from other substances, the saccharum and fecula of the malt, with a sufficient portion, and no more, of its gluten. Care is requisite that he does not defeat this object, by extracting the fecula in an insoluble, instead of in a dissolved state, as is frequently done, by too low mashing heats (in a mode similar to the obtainment of fecula, in the making of starch); and also by dissolving too much of the gluten of the malt, by too high mashing heats, and thereby causing such an intimate combination of the saccharum and fecula with the gluten, making a thick and glutinous compound, as cannot be separated from the malt, and thereby rendering the whole contents of the mash tun, fit only for food to cattle.

But the cause of these evils, are not to be attributed to a defect in the mode of grinding; or to grinding, instead of crushing between rollers, or the reverse; but to the application of an improper extracting heat. Nevertheless, if too high, or too low a heat is taken, crushing or coarse grinding may save a wort, which otherwise would have been lost.

To such Brewers as have not an experience and knowledge, sufficient to dictate to them, what mashing heat is requisite, upon a previous examination of the malt, coarse grinding or crushing, must be to them the safest mode; because the particles, not being so minutely divided, the effects as described, arising from too low or too high heats, are not so likely to ensue.

Those who from defective mechanical arrangements sustain a very considerable loss of saccharum and fecula, which is borne away by the air, when in grinding the particles are too minutely divided, will find crushing or coarse grinding preferable.

But with such as have a competent knowledge of the brewing business, and possess the means and disposition to make the necessary mechanical arrangements,

either crushing, high or low grinding, would be resorted to, according to the state and quality of the malt.

Malt well made, and not damp, is perfectly free and pulverulent, and coarse grinding or crushing effects a sufficient subdivision of its component parts, as to enable the menstruum to dissolve those which are soluble, and is preferable to low or fine grinding, as it prevents the loss of so much saccharum and fecula, which the greatest mechanical conveniences cannot entirely prevent. But malt, which is slack, or of bad quality, possessing but little saccharum and fecula, or part of its fecula, not converted into saccharum, which, by a good process of malting, might have been, a low grinding of such is preferable, if a suitable mashing heat is taken: but causes a greater liability of setting the goods, if an improper heat is taken. And such malt, I imagine, would also be somewhat improved, if, after being ground low (fine), it was in that state exposed awhile to the action of atmospheric air, therefrom absorbing oxygen, and thereby increasing the quantity of saccharum.

Although I am an advocate for the occasional use of stones, either for coarse or fine grinding; yet I wish it to be understood, that I most decidedly prefer crushing, unless malt is unavoidably of bad quality, or in a bad state, as to keeping. But grinding should ever be resorted to as a remedial expedient, for an unavoidable evil; and not as a preventative or curative. Every Brewer should take care that all the mechanical and other arrangements of his Brewery are made on right principles; that he obtains good grain for malting, or good malt, by purchase, if it is to be got; that he causes it to be well malted and well preserved, after it is malted; and he will find that when such measures can be, and are pursued, that crushing his malt for mashing will be the best method.

The proper mechanical arrangements for crushing or grinding, should comprise one or more bins, to receive the whole malt, placed a sufficient height above the rollers or stones, so as to allow the malt to pass from the bins to the rollers or stones, over inclined wire screens, so arranged and connected with the machinery of the mill, as to separate the whole of the malt dust and any extraneous substances mixed with the malt from it, without the necessity of any previous screening by the usual malt-room screen.

The malt should next pass from the rollers or stones into a ground malt bin, placed sufficiently high above the mash tun, as to admit of the malt running into it, by a covered shute, &c. Such an arrangement will save much manual labour, and much of the very best portion of the malt, of which too much is frequently lost by grinding into sacks.

CHAP. V.

FIRST MASHING HEAT.

The malt being prepared for infusion, the first process is the preparation of the menstruum (water or return wort), at a suitable temperature, for the purpose of dissolving those soluble materials which the malt contains. And truly important indeed is this first step in the process! For on the suitability of the temperature, of the mashing menstruum, in every stage of mashing, depends the successful issue of the process; but more particularly as relates to the first mashing heat.

The reader has already been apprised, that malt contains several substances; and it now devolves on me to state that, as a necessary prelude to the production of good beer, it is requisite that the whole of the saccharum and fecula, and but a portion of the gluten, which malt contains should be extracted. To obtain the whole of the saccharum and fecula, and but a part of the gluten, a certain temperature of the mashing menstruum is necessary, to completely dissolve the one, and partially dissolve the other.

If it was possible, in common practice, that a Brewer could ascertain the exact quantity of each of the constituent substances of the malt which he brews, at each successive brewing, then it would be truly desirable that he should endeavour to find out what proportion of gluten he ought to extract from the malt; and in the next place, what would be the most suitable

mashing heat to effect his purpose. Such an attainment might constitute the possessor, the master of a compleat and perfect system of malt extraction; but if analysis is the only medium, to the acquisition of such a knowledge, it must be obviously plain, that the cost and labour of the obtainment would not be compensated by an adequate value in the result.

Although I am perfectly aware, that to endeavour to attain to a perfect system in the production of many manufactured articles, may not ensure a profitable result, it does not follow that it may not be highly advantageous to a manufacturer, to push improvement to the point where advantage ends, and loss begins; but such endeavours should be under the control of a sound judgment.

The generality of writers on the subject of Brewing, furnish their readers with the information, that the first mashing heat should be from 160 to 180 degrees; but they give no reason why it should be so. They very easily and conveniently furnish a scale sufficiently extensive to err in; but they yield no proof of the consequences of the errors which may be committed. If a Brewer, relying on such vague and unsatisfactory directions, conceives it quite immaterial what may be his first mashing heat, provided he keeps within the prescribed limits, he must necessarily sustain a very considerable loss of extract, frequently; and be subject to continual variations in the quality of his beer. He may possibly take his heat at 160 degrees, when it should be 180 degrees; and again, at 180, when it should be 160. And what is to prevent him from so doing? At all events, it cannot be by any information (worth receiving), which any such authors furnish.

I believe that very many Brewers make it an invariable rule to mash with water or return wort, at one heat, the first mash, all the year round, and at the

temperature of 170 degrees or thereabout, choosing it as a medium between the extremes of the scale furnished; and, in the absence of a satisfactory knowledge of the subject, they doubtless do right.

But more accommodating than such authors, I give a scale, as will be seen by the following Tables of mashing heats, exhibiting an average difference of about 49° between the extreme points. And if I was merely to state that the first mashing heat should be taken from 155 degrees to 204 degrees, and the same principle was to be pursued by my readers, relying on the correctness of my assertion, as is done by many of the readers of other authors, I should expect more anathemas than blessings for the statement.

Destitute as we are, and possibly ever may be, of the means of ascertaining, with sufficient practical facility, the quantity of each of the component parts of the malt to be brewed; and from such data, to determine the most suitable first mashing heat, so as to dissolve the whole of the saccharum and fecula, and a proper proportion of the gluten, we must have recourse to the best practical means of judging which we can obtain; and on which I now propose to make a few observations.

Some of the same authors, to whom I have before referred, inform us, that if the first wort comes down from the mash tun, into the under back, at from 144 to 150 degrees of heat, when about half-down, it is a decided proof, that the first mashing heat was correctly taken.

This fact is founded upon the results of a long standing experience, and upon the observations of those who have found that when the wort has so come down, that the malt has then yielded a good extract, &c. and the beer produced has proved good. But although it is doubtless very pleasant to know when we have done

right, it would unquestionably be much more pleasant and profitable to know at all times how to do right before hand, instead of merely knowing it after that we have so done.

As relates to the first mashing heat, I feel much pleasure in being able to say, that I have discovered the means to tell a priori, what should be the first mashing heat, that will ensure the worts coming down at from 144 to 150 degrees, or any other heat; and I can truly say, at the end of about 20 years' extensive practice, I never remember to have found the first wort from any Brewing, in which I have been engaged, running off at a heat beyond due limits on either side, when about half run down. And the means by which so desirable a result is obtained, it is my province now to disclose.

A little reflection must convince any one, that if a quantity of water, (say) at 180 degrees of heat, is added to a quantity of malt; and the resulting wort comes off at from 144 to 150 degrees of heat, or either more or less, that there must be a cause for the difference, and probably more causes than one.

It is usual with some Brewers first to shoot the malt into the mash tun, and then add the menstruum to it, running it from the copper into a trunk, fixed vertically at the side of the mash tun, with one or more orifices at the bottom, discharging the liquor between the real and false bottoms of the mash tun, or else by an enclosed pipe, connecting the real bottom of the mash tun, with what is termed a safe (a vessel receiving the liquor first from the copper,) and the connecting pipe conveying it between the real and false bottoms of the mash tun. By either of such methods, it is usual to adjust the mashing heat of the menstruum, in the copper.

In two different Breweries, I have ascertained that

the average loss of heat of the mashing liquor was eleven degrees in its transit from the copper to the mash tun in one Brewery, and but three degrees in the other. Now suppose, that in both Breweries I had adjusted the heat of the mashing liquor, in the copper to 170 degrees, the consequence would have been that, in one premises, I should have mashed with liquor at 159 degrees, and in the other at 167 degrees. In the first case, the liquor ran from the copper into a safe, and from thence into the bottom of the mash tun, by a copper pipe, and as the mash tun was placed about six feet from the copper, and the conveying pipe situated, so as to be subject to a considerable draught of air, a more than usual loss of heat in transit was the consequence. In the second case, the mash tun was placed close to the copper, and the liquor ran direct therefrom into a trunk, as before alluded to.

It must be evident therefore that, as on the premises referred to, so great a difference in the loss of heat was experienced; it is more than probable that many Brewers are sustaining an equal loss, and some not conscious of it.

Some Brewers make it their practice, first to get their mashing liquor into the mash tun, then cool it down to what they consider a right temperature, and afterwards add the malt, continuing to mash during the time that it is running in, and at first sight this may appear much the most consistent and advantageous method. But on reflection, it appears to me that such method is not the best, and that the continued mashing during the time it is running in, is the most objectionable part of it. For if reference is made to the Table of mashing heats contained in this Chapter, it will be found that the larger the quantity of liquor used for the first mash, the less should be its temperature; for if it is desirable that the first wort should come down at a

temperature of from 144 to 150 degrees, or thereabout, (which I believe it should) when about half down, or in other words, that the temperature of the liquor and malt when mixed, should be at from 144 to 150 degrees in the mash tun; then it will be found indispensably requisite, that in order to ensure the obtainment of such a temperature, due regard must be paid to the quantity and heat of the mashing liquor, and the quantity and heat of the malt.

Assuming it as a fact, that the best and largest extract of the soluble materials of the malt is made, when the mean temperature of the liquor and malt mixed is from 144 to 150 degrees of heat, it must be evident, that the sooner that such mean temperature is acquired the better, and that the best way to effect it, is to get the two bodies together, and mix them as quick as possible.

But in case the liquor is first got into the mash tun, and adjusted to a right heat, and the first malt which falls upon the surface of the liquor is stirred in, and the process of mashing is continued as the malt runs down, —it is quite plain that the first portion of the malt comes in contact with the liquor at its greatest heat, and the last portion at its lowest heat, and that a gradual diminution in the temperature of the mashing liquor takes place—from the time the first portion of malt is added, until the whole is down. If then, the best extracting heat is at from 144 to 150 degrees, and a portion of the malt is subject to the action of the liquor at a temperature of (say) from 170 to 180 degrees, is not a loss of extract from such portion a necessary consequence arising from the partial setting of the goods; the loss diminishing gradually as the mashing progressively advances.

It appears to me preferable, that either in case the liquor is added to the malt or the malt to the liquor, that the addition should be completed before mashing commences, for although that portion of the malt which

comes in contact with the surface of the mashing liquor, must unavoidably be subject to the improper temperature, yet that portion is but small, compared with the whole bulk, and while the addition is making, a portion of the heat from the mashing liquor is diffused among the malt, and the latter becomes gradually prepared for the process of solution, before the mashing commences.

To those to whom the addition of the liquor to the malt is most convenient, or in some cases absolutely necessary, I must strongly recommend that they carefully ascertain, by a series of examinations, what is the average loss of temperature sustained by the mashing liquor in transit, from the copper to the mash tun, and in taking the heat of the liquor in the copper, that they make suitable allowance for such loss.

Having endeavoured to point out clearly the necessity of correctly taking a right first mashing heat, and such being done, then properly mixing the malt and mashing liquor, and with as much speed as possible: I will next endeavour to point out the means by which may be ascertained, what should be the correct mashing heat of the liquor, so as that the mean temperature of the goods when mashed, may be at from 144 to 150 degrees of heat, or thereabout.

But before I attempt to inform the reader of the method, I must inform him that I by no means consider it a perfect one, but as probably the best which may be attainable.

The principle of the method is to ascertain the heat and weight of the malt, then to find out the weight of the liquor intended to mash with; and taking the mean temperature of the goods after mashing, at any point from 144 to 150 degrees; then to deduce therefrom, at what temperature the mashing liquor should be, so that the admixture may be of the required heat.

per bushel, which will comprise the whole of the general extreme difference in the weight of barley malt, and they will be found to give the first mashing heats at a temperature, when ground or crushed, and at the time of mashing, varying from 40 to 80 degrees, and the quantity of the mashing liquor varying from one and a-half to five barrels per quarter.

If the reader refers to the 2nd Table, he will find that should his malt weigh 38lbs. per imperial bushel, and he intends to mash with two imperial barrels of liquor per quarter of malt, and the heat of it at the time of mashing is 40 degrees, that the first mashing heat should be 188 degrees, but if on the contrary, the heat of his malt should be 80 degrees, than the mashing heat should be 171, making a difference of 17 degrees. And allow me to ask any Brewer, if in the winter months, the heat of his malt, may not frequently be as low as 40 degrees, and in some peculiar cases, even lower; and whether in the summer months, that his malt may not (being mashed as soon as ground or crushed, and heated above the temperature of the atmosphere, the necessary consequence of grinding or crushing,) be as high as 80 degrees of heat; and whether also cases may not occasionally occur, when he may have occasion to Brew malt fresh from the kiln, and before it has had time to be reduced to the temperature of the atmosphere.

I have taken 144 degrees as the mean heat for calculation, in the construction of those Tables, because I generally find in practice, the mean heat something higher than the indication of the Tables, which result I attribute to the conversion of latent heat into active, the consequence of the decomposition of the malt, in the process of solution.

In the evening previous to the day of Brewing, a Thermometer should be thrust into the ground malt, in-

tended to be brewed, and by the following morning it will indicate an average temperature sufficiently accurate.

Explanation relative to the use of the Tables:—The weight of a bushel of the malt about to be brewed being ascertained, take the Thermometer out of the malt just before mashing, and note its temperature. Let us suppose that the weight of the malt is 40lbs. per bushel, and its heat 50 degrees, and you intend to mash with 2 barrels of water per quarter, then refer to the first column of the third Table, and find 50° then in a line therewith, and in the third column, under the head of 2 barrels, you will find 185¾ degrees, which should be the heat of the mashing water.

MASHING TABLE FOR MALT,

Heat of Malt	Number of Barrels of Mashing Menstruum, per quarter of Malt.						
Deg.	1½	1¾	2	2¼	2½	2¾	3
40	199½	191½	185½	181	177¼	174¼	171¾
41	199	191	185	180½	177	174	171½
42	198½	190½	184¾	180¼	176½	173¾	171
43	197¾	190	184¼	180	176¼	173½	170
44	197¼	189¾	183¾	179½	176	173	170½
45	196¾	189½	183¼	179¼	175¾	172¾	170¼
46	196¼	188¾	183	179	175¼	172½	170
47	195¾	188¼	182½	178¾	175	172¼	169
48	195¼	187¾	182¼	178½	174¾	172	169½
49	194¾	187¼	181¾	178¼	174¼	171¾	169¼
50	194	187	181½	178	174	171½	169
51	193½	186½	181	177½	173¾	171¼	168
52	193	186	180½	177	173½	170¾	168½
53	192½	185½	180¼	176¾	173	170½	168¼
54	192	185	180	176¼	172¾	170¼	168
55	191½	184½	179½	176	172½	170	167¾
56	191	184¼	179	175½	172	169¾	167½
57	190½	183¾	178½	175	171¾	169½	167¼
58	190	183¼	178¼	174¾	171½	169¼	167
59	189¼	182¾	177¾	174¼	171	169	166¾
60	188¾	182¼	177¼	174	170¾	168¾	166¼
61	188¼	181¾	176¾	173¾	170¼	168¼	166
62	187¾	181½	176½	173¼	170	168	165¾
63	187¼	181	176¼	173	169¾	167¾	165½
64	186½	180½	175¾	172½	169½	167½	165¼
65	186	180	175¼	172	169¼	167¼	165
66	185½	179½	175	171¾	168¾	167	164¾
67	185	179	174½	171½	168½	166¾	164½
68	184½	178¾	174¼	171	168	166½	164¼
69	184	178¼	173¾	170¾	167¾	166	164
70	183½	177¾	173½	170¼	167½	165¾	163¾
71	183	177¼	173	169¾	167	165¼	163½
72	182½	176¾	172½	169½	166¾	165	163
73	182	176¼	172¼	169	166½	164¾	162¾
74	181¾	176	171¾	168¾	166¼	164½	162½
75	181¼	175½	171½	168½	166	164¼	162¼
76	180¾	175	171	168	165¾	164	162
77	180¼	174½	170½	167¾	165½	163¾	161¾
78	179¾	174	170¼	167½	165	163½	161½
79	179¼	173¾	169¾	167	164¾	163	161¼
80	178¾	173¼	169½	166¾	164½	162¾	161

WEIGHING 36lbs. PER BUSHEL.

Heat of Malt.	Number of Barrels of Mashing Menstruum, per quarter of Malt.							
Deg.	3¼	3½	3¾	4	4¼	4½	4¾	5
40	169½	167½	166½	164¾	163½	162½	161½	160¼
41	169¼	166	166¼	164½	163¼	162¼	161¼	160½
42	169	166¾	166	164¼	163	162	161	160½
43	168¾	166½	166	164	163	162	161	160¼
44	168½	166¼	165¾	164	162¾	161¾	160¾	160
45	168½	166	165½	163¾	162½	161½	160½	160
46	168¼	166	165¼	163½	162½	161¼	160½	159¾
47	168	165¾	165	163½	162¼	161	160¼	159½
48	167¾	165½	164¾	163¼	162	161	160	159½
49	167½	165¼	164½	163	162	160¾	160	159¼
50	167¼	165	164¼	163	161¾	160½	159¾	159
51	167	164¾	164	162¾	161½	160¼	159½	159
52	166¾	164½	163¾	162½	161¼	160¼	159½	158¾
53	166½	164¼	163½	162¼	161	160	159¼	158½
54	166¼	164	163¼	162	161	160	159	158½
55	166	163¾	163	161¾	160¾	159¾	159	158¼
56	165¾	163½	162¾	161½	160½	159½	158¾	158
57	165½	163¼	162½	161¼	160¼	159½	158½	158
58	165¼	163	162½	161	160	159¼	158½	157¾
59	165	162¾	162¼	161	160	159	158¼	157½
60	164¾	162½	162¼	160¾	159¾	159	158	157½
61	164½	162¼	162	160½	159½	158¾	158	157¼
62	164¼	162	162	160¼	159¼	158½	157¾	157
63	164	162	161¾	160	159	158¼	157½	157
64	163¾	161¾	161½	159¾	159	158	157½	156¾
65	163½	161½	161¼	159½	158¾	158	157¼	156½
66	163¼	161¼	160¾	159¼	158½	157¾	157	156½
67	163	161	160½	159	158¼	157½	157	156¼
68	162¾	160¾	160¼	159	158	157½	156¾	156
69	162½	160½	160	158¾	158	157¼	156½	156
70	162¼	160¼	159¾	158½	157¾	157	156½	155¾
71	162	160	159½	158¼	157½	157	156¼	155½
72	161¾	160	159	158	157¼	156¾	156¼	155½
73	161½	159¾	159	158	157	156½	156	155¼
74	161¼	159½	158¾	157¾	157	156½	156	155
75	161	159¼	158½	157½	156¾	156¼	155¾	155
76	160¾	159	158¼	157¼	156½	156	155½	154¾
77	160½	158¾	158	157	156½	156	155½	154½
78	160¼	158½	157¾	157	156¼	155¾	155¼	154½
79	160	158¼	157½	156¾	156	155½	155	154¼
80	159¾	158	157½	156½	156	155½	155	154

MASHING TABLE FOR MALT,

Heat of Malt.	Number of Barrels of Mashing Menstruum, per quarter of Malt.						
Deg.	1½	1¾	2	2¼	2½	2¾	3
40	202¼	194½	188	183	179	176	173¼
41	202	194	187½	182¾	178¾	175¾	173
42	201¼	193½	187	182¼	178½	175¼	172¾
43	200¾	193	186¾	182	178	175	172½
44	200¼	192½	186¼	181½	177½	174¾	172¼
45	199½	192	185¾	181	177¼	174½	172
46	199	191½	185½	180¾	177	174	171½
47	198½	191	185	180¼	176¾	173¾	171¼
48	198	190½	184½	180	176¼	173½	171
49	197½	190	184	179¾	176	173¼	170¾
50	197	189½	183¾	179¼	175¾	173	170½
51	196½	189	183¼	179	175¼	172¾	170¼
52	196	188½	183	178½	175	172½	170
53	195¼	188	182½	178	174½	172	169½
54	194½	187¾	182	177¾	174¼	171¾	169¼
55	194	187¼	181½	177¼	174	171¼	169
56	193¼	186¾	181	177	173½	171	168¾
57	192¾	186¼	180½	176¾	173¼	170¾	168½
58	192¼	186	180¼	176½	173	170¼	168¼
59	191¾	185½	180	176	172½	170	168
60	191¼	185	179½	175½	172¼	169¾	167½
61	190½	184½	179	175	172	169½	167¼
62	189¾	184	178¾	174¾	171½	169¼	167
63	189¼	183½	178¼	174¼	171¼	169	166¾
64	188¾	183	178	174	171	168½	166½
65	188½	182½	177½	173¾	170¾	168¼	166¼
66	187¾	182	177	173¼	170½	168	166
67	187¼	181½	176¾	173	170	167½	165½
68	186½	181	176¼	172¾	169½	167¼	165¼
69	186	180½	175¾	172¼	169¼	167	165
70	185½	180	175¼	171¾	169	166½	164¾
71	185	179½	175	171½	168½	166¼	164½
72	184¼	179	174½	171	168¼	165¾	164¼
73	183¾	178½	174	170¾	168	165¼	164
74	183¼	178	173½	170½	167½	165	163¾
75	182½	177½	173	170¼	167¼	164½	163½
76	182	177	172½	169½	167	164¼	163¼
77	181½	176½	172¼	169¼	166½	164	163
78	181	176	172	168¾	166¼	163¾	162½
79	180½	175½	171½	168½	166	163½	162¼
80	180	175	171	168	165½	163¼	162

WEIGHING 38lbs. PER BUSHEL.

Heat of Malt.	Number of Barrels of Mashing Menstruum, per quarter of Malt.							
Deg.	3¼	3½	3¾	4	4¼	4½	4¾	5
40	171	169½	167½	166	164½	163½	162½	161½
41	170¾	169¼	167½	165¾	164¼	163¼	162¼	161½
42	170½	169	167¼	165½	164	163	162	161¼
43	170¼	168¾	167	165¼	164	163	162	161
44	170	168½	166¾	165	163¾	162¾	161¾	161
45	169¾	168¼	166½	165	163½	162½	161½	160¾
46	169½	168	166¼	164¾	163¼	162¼	161½	160½
47	169¼	167¾	166	164½	163	162	161¼	160½
48	169	167½	166	164¼	163	162	161	160¼
49	168¾	167¼	165¾	164	162¾	161¾	161	160
50	168½	167	165½	164	162½	161½	160¾	160
51	168¼	166¾	165¼	163¾	162¼	161¼	160½	159¾
52	168	166½	165	163½	162	161	160¼	159½
53	167¾	166¼	164¾	163¼	162	161	160	159½
54	167½	166	164½	163	161¾	160¾	159¾	159¼
55	167¼	165¾	164¼	163	161½	160½	159½	159
56	167	165½	164	162¾	161¼	160½	159½	159
57	166¾	165¼	163¾	162½	161	160¼	159¼	158¾
58	166½	165	163½	162¼	161	160	159	158½
59	166¼	164¾	163¼	162	160¾	160	159	158½
60	166	164½	163	161¾	160½	159¾	158¾	158¼
61	165¾	164¼	163	161½	160¼	159½	158½	158
62	165½	164	162¾	161¼	160	159¼	158½	158
63	165¼	164	162½	161	160	159	158¼	157¾
64	165	163¾	162¼	161	159¾	159	158	157½
65	164¾	163½	162	160¾	159½	158¾	158	157½
66	164½	163¼	161¾	160½	159¼	158½	157¾	157¼
67	164¼	163	161½	160¼	159	158½	157½	157
68	164	162¾	161¼	160	159	158¼	157½	157
69	163¾	162½	161	160	158¾	158	157¼	156¾
70	163½	162¼	160¾	159¾	158½	158	157	156½
71	163¼	162	160½	159½	158¼	157¾	157	156½
72	163	161¾	160¼	159¼	158	157½	156¾	156¼
73	162½	161½	160¼	159	158	157¼	156½	156
74	162¼	161¼	160	158¾	157¾	157	156½	156
75	162	160¾	159¾	158½	157½	157	156¼	155¾
76	161¾	160½	159½	158¼	157¼	156¾	156	155½
77	161½	160½	159¼	158	157	156½	156	155½
78	161¼	160¼	159	158	157	156¼	155¾	155¼
79	161	160	158¾	157¾	156¾	156	155½	155
80	160¾	159¾	158½	157½	156½	156	155½	155

MASHING TABLE FOR MALT,

Heat of Malt.	Number of Barrels of Mashing Menstruum, per quarter of Malt.						
Deg.	1½	1¾	2	2¼	2½	2¾	3
40	205½	197	190¼	185	180½	177½	175
41	205	196½	189¾	184½	180	177¼	174½
42	204½	196	189¼	184	179¾	177	174¼
43	203¾	195½	189	183¾	179½	176½	174
44	203¼	195	188½	183¼	179	176¼	173¾
45	202½	194½	188	183	178¾	176	173¼
46	202	194	187½	182½	178½	175½	173
47	201½	193½	187	182	178	175¼	172½
48	200¾	193	186½	181¾	177¾	175	172¼
49	200¼	192½	186¼	181¼	177¼	174½	172
50	199¾	192	185¾	181	177	174¼	171¾
51	199	191¾	185¼	180¾	176½	174	171½
52	198½	191¼	185	180¼	176¼	173¾	171¼
53	198	190¾	184½	180	176	173½	171
54	197½	190½	184	179½	175½	173	170½
55	196½	190	183½	179	175¼	172¾	170¼
56	196	189¼	183	178¾	175	172½	170
57	195½	188¾	182½	178¼	174½	172	169½
58	195	188¼	182¼	178	174¼	171¾	169¼
59	194¼	187¾	181¾	177½	174	171½	169
60	193¾	187¼	181¼	177	173½	171	168¾
61	193	186½	181	176¾	173¼	170¾	168½
62	192½	186	180½	176¼	173	170½	168¼
63	192	185½	180¼	176	172½	170¼	168
64	191¼	185	180	175½	172	170	167½
65	190½	184½	179½	175	171¾	169½	167¼
66	190	184	179	174¾	171½	169¼	167
67	189½	183½	178½	174¼	171	169	166½
68	189	183	178	174	170¾	168½	166¼
69	188¼	182½	177½	173½	170½	168¼	166
70	187¾	182	177	173	170	168	165¾
71	187	181½	176½	172¾	169¾	167¾	165½
72	186½	181	176	172¼	169½	167½	165¼
73	186	180½	175½	172	169	167	165
74	185½	180	175	171½	168½	166¾	164½
75	184¾	179½	174½	171	168¼	166½	164¼
76	184¼	179	174	170¾	168	166¼	164
77	183¾	178½	173¾	170¼	167½	166	163½
78	183	178	173¼	170	167¼	165¾	163¼
79	182½	177½	173	169½	167	165¼	163
80	182	177	172½	169	166½	165	162¾

WEIGHING 40lbs. PER BUSHEL.

Heat of Malt.	Number of Barrels of Mashing Menstruum, per quarter of Malt.							
Deg.	3¼	3½	3¾	4	4¼	4½	4¾	5
40	172½	171	168¾	167¼	165½	164½	163½	162¾
41	172¼	170¾	168½	167	165¼	164¼	163¼	162½
42	172	170½	168¼	167	165	164	163	162¼
43	171¾	170	168	166¾	165	164	163	162
44	171½	169¾	167¾	166½	164¾	163¾	162¾	162
45	171¼	169½	167½	166¼	164½	163½	162½	161¾
46	171	169¼	167¼	166	164¼	163¼	162¼	161½
47	170½	169	167	166	164	163	162	161¼
48	170¼	168¾	166¾	165¾	164	163	162	161
49	170	168½	166½	165½	163¾	162¾	161¾	161
50	169¾	168¼	166¼	165¼	163½	162½	161½	160¾
51	169½	168	166	165	163¼	162¼	161¼	160½
52	169¼	167¾	165¾	165	163	162	161	160½
53	169	167½	165½	164¾	162¾	162	161	160¼
54	168¾	167¼	165¼	164½	162½	161¾	160¾	160
55	168½	167	165	164¼	162¼	161½	160½	160
56	168¼	166½	165	164	162	161¼	160¼	159¾
57	168	166¼	164¾	163¾	162	161	160	159½
58	167¾	166	164½	163½	161¾	161	160	159¼
59	167½	165¾	161¼	163¼	161½	160¾	159¾	159
60	167¼	165½	164	163	161¼	160½	159½	159
61	167	165¼	163¾	162¾	161	160½	159¼	158¾
62	166½	165	163½	162½	161	160¼	159	158½
63	166¼	164¾	163¼	162¼	160¾	160	159	158¼
64	166	161½	163	162	160½	160	158¾	158
65	165¾	164¼	162¾	162	160¼	159¾	158½	157¾
66	165½	164	162½	161¾	160	159½	158¼	157½
67	165¼	163¾	162¼	161½	159¾	159¼	158	157¼
68	165	163½	162	161¼	159½	159	158	157
69	164¾	163¼	162	161	159¼	159	157¾	157
70	164½	162¾	161¾	160¾	159	158¾	157½	156¾
71	164¼	162½	161½	160½	159	158½	157¼	156½
72	164	162	161¼	160¼	158¾	158¼	157	156¼
73	163¾	161¾	161	160	158½	158	157	156
74	163½	161½	160¾	159¾	158¼	158	156¾	156
75	163	161¼	160½	159½	158	157¾	156¾	155¾
76	162¾	161	160¼	159¼	158	157½	156½	155½
77	162½	160¾	160	159	157¾	157¼	156½	155½
78	162¼	60½	159¾	159	157½	157	156¼	55¼
79	162	160¼	159½	158¾	157¼	157	156	155
80	161¾	160	159¼	158½	157	156¾	156	155

MASHING TABLE FOR MALT,

Heat of Malt	Number of Barrels of Mashing Menstruum, per quarter of Malt.							
Deg.	1½	1¾	2	2¼	2½	2¾	3	3¼
40	208¾	199½	192½	187¼	182¾	179¼	176½	174
41	208¼	199	192	186¾	182¼	179	176¼	173¾
42	207½	198½	191½	186¼	182	178½	176	173½
43	206¾	198	191	186	181½	178¼	175½	173¼
44	206	197½	190½	185½	181	178	175¼	173
45	205½	197	190	185	180½	177½	175	172¾
46	205	196½	189½	184¾	180¼	177¼	174½	172½
47	204¼	196	189	184¼	180	177	174¼	172
48	203¾	195¼	188½	184	179½	176½	174	171¾
49	203	194¾	188	183½	179	176¼	173½	171½
50	202½	194¼	187½	183	178¾	176	173¼	171¼
51	202	193¾	187¼	182¾	178¼	175½	173	171
52	201¼	193¼	186¾	182¼	178	175¼	172½	170¾
53	200½	192¾	186¼	182	177½	175	172¼	170½
54	200	192	186	181½	177	174½	172	170¼
55	199¼	191½	185½	181	176¾	174¼	171¾	170
56	198¾	191	185	180¾	176¼	174	171½	169½
57	198	190½	184½	180¼	176	173½	171¼	169¼
58	197½	190	184	180	175½	173¼	171	169
59	196¾	189½	183½	179½	175	173	170½	168¾
60	196¼	189	183¼	179	174¾	172½	170¼	168½
61	195½	188½	182¾	178¾	174¼	172¼	170	168¼
62	195	188	182½	178½	174	172	169½	168
63	194¼	187¼	182	178	173¾	171½	169¼	167¾
64	193¾	186¾	181½	177½	173½	171¼	169	167½
65	193	186¼	181¼	177	173	171	168¾	167
66	192½	185¾	181	176½	172½	170½	168¼	166¾
67	191¾	185¼	180½	176	172	170¼	168	166½
68	191¼	184¾	180	175¾	171¾	170	167¾	166¼
69	190½	184	179½	175¼	171¼	169½	167½	166
70	190	183½	179¼	175	171	169¼	167	165¾
71	189½	183	178½	174½	170¾	169	166¾	165¼
72	189	182½	178	174	170¼	168½	166½	165
73	188¼	182	177½	173¾	170	168	166	164¾
74	187¾	181½	177	173½	169½	167½	165¾	164½
75	187	181	176½	173	169	167¼	165½	164¼
76	186½	180½	176¼	172½	168¾	167	165¼	164
77	185¾	180	176	172¼	168¼	166¾	165	163¾
78	185¼	179¼	175¾	171¾	168	166½	164½	163½
79	184½	179	175½	171¼	167¾	166¼	164¼	163
80	184	178¼	175	170½	167½	166	164	162½

WEIGHING 42lbs. PER BUSHEL.

Heat of Malt.	Number of Barrels of Mashing Menstruum, per quarter of Malt.					
Deg.	3½	3¾	4	4¼	4½	4¾	5
40	172½	170	168½	166½	165½	164½	163
41	172¼	169¾	168¼	166¼	165¼	164¼	162¾
42	172	169½	168	166	165	164	162½
43	171¾	169¼	167¾	165¾	165	164	162¼
44	171½	169	167½	165½	164¾	163¾	162
45	171¼	168¾	167¼	165¼	164½	163½	162
46	171	168½	167	165	164¼	163¼	161¾
47	170½	168¼	166¾	165	164	163	161½
48	170¼	168	166½	164¾	163¾	163	161½
49	170	167¾	166½	164½	163½	162¾	161¼
50	169¾	167½	166¼	164¼	163½	162½	161
51	169½	167¼	166	164	163¼	162¼	161
52	169¼	167	165¾	163¾	163	162	160¾
53	169	166¾	165½	163½	162¾	162	160½
54	168¾	166½	165¼	163¼	162½	161¾	160¼
55	168½	166¼	165	163	162¼	161½	160
56	168¼	166	164¾	163	162	161¼	160
57	168	165¾	164½	162¾	162	161	159¾
58	167½	165	164¼	162½	161¾	161	159½
59	167¼	164¾	164	162¼	161½	160¾	159½
60	167	164½	164	162	161¼	160½	159¼
61	166¾	164¼	163¾	161¾	161	160¼	159
62	166½	164	163½	161½	160¾	160	159
63	166¼	163¾	163¼	161¼	160½	160	158¾
64	166	163½	163	161	160½	159¾	158½
65	165½	163¼	162¾	161	160¼	159½	158¼
66	165¼	163	162½	160¾	160	159¼	158
67	165	162¾	162¼	160½	159¾	159	158
68	164¾	162½	162	160¼	159½	159	157¾
69	164½	162¼	161¾	160	159½	158¾	157½
70	164¼	162	161½	159¾	159¼	158½	157½
71	164	161¾	161½	159½	159	158¼	157¼
72	163¾	161½	161¼	159¼	158¾	158	157
73	163½	161¼	161	159	158½	158	157
74	163¼	161	160¾	158¾	158¼	157¾	156¾
75	163	161	160½	158½	158	157½	156½
76	162¾	160¾	160¼	158¼	157¾	157¼	156¼
77	162¼	160½	160	158¼	157½	157	156
78	162	160½	159¾	158	157¼	157	156
79	161¾	160¼	159½	157¾	157	156¾	155¾
80	161½	160	159½	157½	157	156½	155½

Having given all the information which occurs to me as necessary relative to the taking a proper heat of the water for the first mash, I next call the attention of the reader to the subject of mashing with return wort.

As in the preceding pages, I have laid it down as a maxim, that the heat of the first mashing liquor must be in proportion to its weight, in conjunction with the weight and heat of the malt, it is quite evident, that if it becomes necessary to mash, with a menstruum of variable weight, that a variable amount of its temperature must be adopted, proportionate to the difference of the weight.

An imperial gallon of water weighs 10lbs., or 36 gallons 360lbs. An imperial gallon of wort, the density of which is 10lbs. by Long's, Swan's, or Dring and Fage's saccharometer, weighs 10lbs. 6oz., or 36 gallons, 373½ lbs. Hence it is quite evident, as the following calculation will show, that the mashing heat of return wort should be less than the mashing heat of water.

Weight of malt, per bushel -	40	lbs.
Bushels per quarter - -	8	
Weight of one quarter malt -	320	
Quarters of malt to mash -	20	
Weight of 20 quarters of malt -	6400	
Heat of the malt - - -	50	
Heat and weight of 20 qrs. of malt	320000	
Weight of 36gals. return wort -	373½	
No. of bls. of wort to mash with	40	
Weight of 40 barrels of return wort	14940	
Weight of 20 quarters malt -	6400	
Wt. of 40bls. ret. wat.& 20qrs. malt	21340	
Heat of return wort and malt, when mixed	144	degrees.
	85360	
	85360	
	21340	
Total heat and weight of goods	3072960	when mashed.

Total heat and weight of goods	3072960 brot. forward.
Substract heat and weight of 20 qrs. of malt	320000
Divide by the weight of 40 bars. of return wort	14940)2752960(184¼° of heat
	14940
	125896
	119520
	63760
	59760
	4000
	4
	14940)16000(1
	14940
	1060

By reference to page 100, it will be seen that if water was used for mashing, instead of a return wort of 10lbs. density, that the proper mashing heat would be 185¾ degrees, and from which deduct 184¼ degrees, a difference of 1½ degrees will be shewn.

As it is very unusual to mash with a return wort of so great a density, as 10lbs., and the difference in the required temperature in such a case is not great, it will be evident that the Tables already furnished are sufficient for both purposes: the Brewer making a difference as circumstances may require.

CHAP. VI.

MASHING AND SPARGING.

Practice and long experience has convinced me that it is best to mash as promptly as possible after the malt and mashing menstruum are together, and to continue the process no longer than is useful to thoroughly amalgamate both.

To mash with a machine if possible, and under cover, until its removal is requisite for the purpose of breaking the balls, &c. by means of rakes; and as soon as that is finished, mashing should then cease, and the mash tun be closely covered up. And theory suggests the proper motive for the adoption of that system, which subsequent practice has proved to be correct.

As there is a proper and suitable temperature at which malt and the mashing menstruum should be, when mixed, in order that the process of extraction may be effected in the most advantageous way; and as heat is the agent in effecting solution, much care should be taken that no more of that which is administered should be lost than is unavoidable; it is therefore necessary that the mashing process should be promptly performed, and under the best possible circumstances, as to cause the loss of the least quantity of heat. And the advantages resulting from a retention of as much of the heat as is administered, as far as is possible, not only applies to the first mashing process, but to every subsequent stage of the process of extrac-

tion. The hotter the goods are left, after the first and subsequent worts are run off, the better condition are they in to yield their soluble materials to the succeeding menstruum. And this conclusion induces the conviction, that as soon as the menstruum at each time administered has performed all the work it is capable of, the sooner it is withdrawn from the goods the better.

The purport of mixing malt and water or return wort, at any given temperature, is not only to create the compound called wort, but to obtain it compounded on right principles, and in a state of transparency.

To accomplish the former, the malt should be of good quality, and properly prepared; and the menstruum of right heat, of suitable quantity, and the wort should be withdrawn from the goods as soon as the menstruum is charged with extract to the utmost point at which it is capable of dissolving; any longer continuance, proves injurious to its quality, in proportion to the time it is allowed to remain beyond such point, the heat of the weather, the state of the atmosphere, and the circumstances of exposure, &c. To accomplish the latter, a sufficient time should be allowed for deposition after the agitation of mashing; and when the taps are set, they should at first be allowed to spend a small stream, which should be gradually increased until it may run nearly or quite full cock. It should therefore be every Brewer's business to ascertain in what average space of time these two points can be gained, and then adapt his system thereto. For my own government, I have ascertained that from the time the whole of the liquor is under the goods, for the first mash, a quarter of an hour is sufficient for the purpose of mashing, a half an hour to effect solution to saturation, and an hour to ensure the needful transparency, so that the

taps may, with the most advantage, be set at the end of one hour, from the time that mashing commences.

I never make but one stirring mash, finding that, for the purpose of extraction, one is quite sufficient, and more is injurious.

When the first mashing liquor is run off from the copper, I charge it with a sufficiency of water as to serve for the purposes of scalding utensils and casks, and the second mash (technically termed "fly mash;") for such mash I use from 20 to 23 barrels of boiling water, which is allowed to run over the goods, running from the copper on a board about 3 feet square, suspended about a foot above the goods, and as near the centre of the mash tun as conveniently can be, which falling upon it with some force, is distributed over the goods in every direction. This mashing liquor gradually finds its way from the upper to the under surface of the goods, effecting solution in its passage, and subsequent state of rest before the taps are set, and during the time they are spending: half an hour is sufficient, for such liquor to remain on the goods, for the purpose of extraction, before the spending taps are set.

As soon as the wort, resulting from the fly mash is down in the under back, the process of sparging commences, and enough wort from one or more sparges is added to the wort already in the under back, as is sufficient to make up enough for the second boiled wort.

The sparging process is continued for the third wort until the last wort which runs from the goods is no longer transparent, which it generally ceases to be when its density is reduced to from 1½ to 2lbs. per barrel.

From a review of the process of extraction, thus far detailed, several important advantages resulting from the adoption of such a system are realised, which are not by the methods usually pursued.

The saving of much time, labour and fuel, the obtainment of a greater and better extract, and in the least quantity of wort, and in the preservation of its quality after it is obtained.

And each of these advantages are important, separately, but much more so in a state of combination.

The preservation of the quality of the wort, is promoted by a quick process of extraction and transit from the under back to the copper, the addition of the hops thereto, and promptly bringing it to a boiling state, and by the least possible exposure of the wort to the atmosphere.

For as wort rapidly absorbs oxygen from the atmosphere, and with more rapidity and in greater quantity at a medium temperature, than when boiling or reduced to the same heat as the atmosphere, or below it: the process of extraction, consistent with completion and right principles, cannot be too promptly effected, and when performed, the resulting wort cannot too soon receive the hops and be brought to a boiling state; and when boiled cannot, for the same reason, be too quickly reduced to the right pitching heat; and the less is the exposure of the wort to the atmosphere during the whole of this operation, the less liable is it to absorb oxygen, the principle of acidity. And as in hot weather, and the vegetative season, the atmosphere is charged with oxygen to a much greater extent, than in cold weather, or when vegetative life is dormant, an attention to these particulars is more importantly necessary.

The effect of sparging, instead of making a stirring or fly mash, is a subject worth considering; inasmuch as a proper comprehension of the effect produced, and the cause of its accomplishment, may the more readily induce its adoption, and also the best means to carry it into effect.

I have already stated that by the process detailed,

a greater quantity of extract, and of better quality, can be obtained from malt, with a less quantity of liquors than can be by the methods commonly adopted; which yields most important advantages, because many are induced to refrain from obtaining all the extract which malt will produce, as by their method of obtainment, the quantity and quality of the latter product are not beneficial to them.

The practice of some is to make a third stirring mash, with cold liquor, some a third with hot, and a fourth with cold, to which there are three strong objections:—the quantity of liquor, its temperature when cold, and the mashing.

The objection to the quantity of liquor is, that every portion of it cannot come in contact with a portion of the malt, and such as does not, cannot act upon such malt as a dissolving menstruum, and would leave the mash tun in the same state as it entered, did it not receive by diffusion a portion of the extract obtained by such liquor, as is in contact; consequently all such liquor as enters the mash tun, and which does not come in contact with the malt, is superfluous, as relates to the purposes of solution.

Cold water will not dissolve so much of the soluble materials of the malt as hot, altogether, and yet will dissólve that which is not wanted, which hot water will not, and a slight observation of the strength, state, and appearance of wort obtained either way, will at once convince that the product of the hot is preferable to that of the cold.

The objections to mashing are, the unnecessary waste of labour, time, and heat, if hot water is used, and the disturbance of those impurities which should not be carried into the under back, and which are consequently the more liable if mashing is resorted to.

The purport of sparging is to distribute at intervals,

a small quantity of hot liquor over the goods, and which is allowed to pass through them, and in their passage to perform the work of solution, and which accomplished, is drawn from the mash tun into the under back, by the spending taps.

This process of sparging on and drawing off, is alternately effected, until as much extract from the malt is obtained as is deemed desirable.

As the object sought, is to obtain much good extract with as small a quantity of dissolving menstruum as is possible, it is not only necessary that sparging should be adopted, so as to accomplish it, but that it should also be carried into effect upon right principles. And the best method which I have known devised for the purpose, is by the aid of what is termed "a sprinkling machine," which revolving round, and its arms embracing nearly the internal diameter of the mash tun, delivers a fine and continual stream of hot water over the surface of the goods, each particle of which has time partly to descend through them, before a succeeding portion is distributed to follow on, to assist in performing that work which the preceding shower had left undone.

The annexed details of one Brewing will convey to the reader, I conceive, all needful information, relative to the general system which I adopt, and any deviation to suit his own views and practice, he can make as his judgment dictates desirable or necessary.

Time when Worts were all run off, from Mash Tun into Under Back.	Mashing and Sparging Heats.	Quantity of Mashing and Sparging Liquor.		Heat of Worts while running from Mash Tun into Under Back.	Quantity of Raw Wort in Under Back.		Density of Raw Wort, per Barrel.	Total Density of the Raw Wort in the Under Back.	SUMMARY.	Time of Day, referring to opposite page.
Hs. Ms.	Deg.	B.	F.	Deg.	B.	F	lb. th	lbs. ths.		Hrs. Mts
										M 6 30
	179	52	0							6 40
										6 50
										7 13
										8 13
M 9 25				149	32	0	35 4	1164 8	First Raw Wort. 32bls.35lbs.4ths.—1164 8	9 25
	212	23	0							9 30
										10 0
										10 5
				156						10 30
11 0					26	3	26 9	703 5		11 0
11 10		1	2	163	1	2	21 5	32 2½		11 10
11 27		2	1	163	2	1	21 2	47 7		11 27
11 51		4	0	163	4	0	19 5	78 0		11 51
E 12 15		4	1	161	4	1	17 8	75 6½		E 12 15
1 15		5	1	157	5	1	12 9	67 7	Second Raw Wort. 48bls.2f.21lbs 6½ths.—1051 1	1 15
1 34		4	2	153	4	2	10 3	46 3		1 34
1 55		2	1	151	2	1	9 7	21 8		1 55
2 20		2	3	153	2	3	9 3	25 5		2 20
										2 30
2 35		2	0	148	2	0	8 8	17 6		2 35
2 50		2	0	148	2	0	8 3	16 6		2 50
3 10		3	0	145	3	0	8 0	24 0		3 10
3 25		3	3	139	3	3	6 1	22 8½		3 25
3 45		4	0	138	4	0	5 2	20 8	Third Raw Wort. 36bls.1f.5lbs.6ths —203 0	3 45
3 57		3	0	135	3	0	4 7	14 1		3 57
4 16		3	1	128	3	1	3 2	10 4		4 16
4 30		2	1	128	2	1	3 8	8 5½		4 30
4 47		2	3	124	2	3	3 2	8 8		4 47
										5 0
5 5		3	3	122	3	3	2 7	10 1		5 5
5 20		1	2	118	1	2	2 1	3 1		5 20
		133	0		116	3		2420 1		

	B. F.	lbs ths.			
Quantity of Boiled Wort in Tun, and Return Wort carried over.	25 2	40 8	1040 4	Average Density of 1st and 2nd Boiled Worts 30lbs.3ths.	Average Density of Raw Wort 20lbs 7ths.
	42 0	24 0	1008 0		
	35 0	5 7	199 6	Average Density of Boiled & Return Wort.--21lbs.9ths	
	102 2		2248 0		

No. 49. April 21st, 1835. Brewed 26 qrs. pale malt for XX ale, with 177lbs. hops.

	lbs.	lbs.	
First wort	41 new, &	54 old hops.	Yeast, 50½ lbs. in ratio of four tenths of an ounce per every pound density contained in boiled wort.
Second do.	35 do. &	47 do.	
	—	—	
	76	101	Tun pitched at 62 degrees.
			Broke into tun 4½ bls. trough beer.

Heat of malt - - 60 degrees.
Weight of do. - - 38lbs. per bushel.

OBSERVATIONS, &c.

Reduced liquor in copper, from 212 to 179 degrees for mashing.
Turned on liquor under goods.
Liquor all off copper.
Mashing finished.
Set spending taps to run off the first wort from the mash tun into under back.
The first wort was all down in under back.
Turned over goods (as fly mash) 23 barrels of boiling liquor.
The first wort was all pumped up, and hops in copper.
Set spending taps to run off the second wort from mash tun into under back.
The first wort began to boil.
The second wort was all down in under back.
First Sparge.
Second do.
Third do.
Fourth do. Struck copper. First wort boiled 1¾ hour.
Fifth and sixth sparges.
Seventh sparge.
Eighth do, Second wort and hops in copper.
Ninth do.
The second wort began to boil.
Tenth sparge.
Eleventh do.
Twelfth do.
Thirteenth do.
Fourteenth do.
Fifteenth do.
Sixteenth do.
Seventeenth do.
Eighteenth do.
The second wort finished boiling, and copper struck. Boiled 2¼ hours.
Nineteenth sparge.
Twentieth do.

The first Boiled Wort as per tun guage.
The second do. do. as do. do.
The return wort carried over for next day's mashing.

The principle on which the sparging apparatus before adverted to is constructed and operates is that of Barker's Mill, with an excepting difference, that the motive power of the latter consists in the rushing of two streams of water, from an orifice in the side of each arm near the end, of considerable size; and in the former from a delivery of a fine stream of water from a row of small holes, made in the opposite side of each arm, the whole of their length.

On reference to Plate 1, Fig. 1st, a sketch will be seen, which, with the following description, will be sufficient to enable a competent workman to construct and fit one up suitable for the purpose.

It may be made of any light malleable metal, but copper is the most suitable, as relates to durability and ultimate value.

(A) The mash tun. (B) A wooden bar placed across and on the top or within the mash tun, as may be most convenient and desirable, for the purpose of affixing in the centre, the solid spindle, (C) If the construction of the mashing machine will admit, the spindle may be fixed on its centre vertical shaft, but if no machine is used, a moveable bar as described, appears to me the most convenient; but let it be fixed in whatever way it may, it should, if possible, be so arranged as that the apparatus may operate under cover, as thereby the loss of much of the heat of the sparging water may be prevented.

(C) The spindle, which may be of iron, and on which revolves the sparging machine.

(D) Is a hollow cylindrical tube, connected with the vessel (E) and formed of the same metal, yet having inserted within it a brass cylindrical tube, sufficiently thick to allow for wear, open at one end for the reception of the spindle, and closed at the other, to furnish a bearing for its head.

(E) Is a hollow cylindrical, or other shaped vessel, capable of containing a few gallons of water, the capacity sufficient to afford a suitable supply, proportionate to the delivery of the arms, without any redundance to impart a superfluous weight, and thereby impede its motion by unnecessary friction.

(F) (F) Are horizontal hollow arms, connected with and opening into the vessel (E) closed at each end by a brass cap, screwed on. The length of these arms should be such as nearly to touch the sides of the mash tun, in order that, in revolving, they may deliver the shower of hot water which issues from the row of holes, with which each arm is closely perforated from one end to the other, over every part of the goods. Each arm should be perforated at opposite sides, as may be understood by reference to the diagram; the dotted row on one exhibiting the perforations, and the omission on the other arm, denoting that the perforations are on the opposite side.

(G) A pipe conveying hot water to the vessel. (E).

(H) (H) Two screw caps, for the purpose of taking off, should the arms at any time require cleansing.

The action of this apparatus may be termed self-acting, as it does not require any other motive power than that which results from the water, flowing in a continual shower from each arm, which displaces the elastic atmosphere surrounding, with a force proportionate to the height of the water in the vessel, (E) above the point of delivery. The air thus displaced, being condensed and elastic, returns with a force equal to that which caused its displacement, and pressing upon the arms of the apparatus, imparts motion at a speed proportionate to the force impressed: And as it is desirable that time should be allowed for the water thus delivered to pass some distance through the goods, before another supply is furnished, the judgment of

the superintendant must be exercised, in regulating the supply of water to the vessel. (E).

If a dome copper is used, the water which is used for sparging may be heated in the pan, by the steam and heat from the water prepared for the first and second mashes, and continued by the subsequent boiling worts. Or if not, a second copper or other apparatus is necessary for the purpose; and as the principal part of the fuel requisite for the heating of the sparging water in a separate vessel may be saved, by the use of a dome copper, irrespective of other important considerations, its superior value in use appears to me to be indubitable, as compared with the open copper.

In conclusion of this Chapter, I can state that by invariably pursuing this system of extraction for several years, I have obtained a much larger and better extract than I ever could obtain by the old system, as was, and still is by many practised, and as annexed, I furnish the average product of four years' Brewings, as relates to quantity of extract obtained in Ale Brewings, from about 2000 quarters of barley malt per annum.

The produce is given in raw and boiled worts, as per under back and tun guages.

The highest, lowest, and average raw and boiled extracts obtained from Pale Barley malt per quarter, in the brewing of ale, &c. denoted in pounds density, as per Swan's, Long's, or Dring and Fage's saccharometer.

YEARS.	Highest Raw Extract.		Highest Boiled Extract.		Lowest Raw Extract.		Lowest Boiled Extract.		Average Raw Extract.		Average Boiled Extract.	
	lbs.	ths.	lbs.	ths.	lbs.	ths.	lbs.	ths.	lbs.	ths.	lbs.	ths.
1831	102	9	91	7	81	0	74	0	91	6	83	0
1832	101	0	93	0	79	4	72	8	89	3	85	2
1833	108	1	99	0	89	2	77	3	96	0	88	0
1834	105	0	91	6	78	7	73	0	93	2	83	7

CHAP. VIII.

HOPS.

The original purport of the impartation of Hop extract to that of malt, in the manufacture of beer, I should imagine was for its preservation; and habit having reconciled the consumer to the resulting flavor, and rendered it grateful to the taste, their use is continued for the double motive. In making his purchases therefore, the Brewer should have an eye to strength and flavor in making his selections.

In carrying into effect a double object, as much care should be taken as is possible to prevent any collision in the results. Thus in selecting Hops for porter and store ale, strength is the primary consideration, and flavor the secondary; but for ale brewed for early consumption, flavor is of the first import.

Brewers should be well aware that Hops of fine quality, will not only yield a fine aromatic flavor, but one that is extremely nauseous.

A Brewer may be careful and fortunate in his selection of hops, possessing both strength and flavor combined, or possessing either separately; but by his method of Brewing may fail in the accomplishment of his wishes, obtaining that which he does not require, falling short in the obtainment of that which he needs, or losing it subsequent to obtainment.

For the government of the judgment, it is necessary

that the Brewer should know, in what way the extract of Hops acts as a preservative to beer, in order that he may regulate his impartations proportionate to the time and circumstances under which he may expect it to be kept.

The preservative properties of Hops, appear to me to consist in the large quantity of carbon, forming one of its constituent principles, and which being imparted to wort in the process of boiling, furnish the required supply to combine with the oxygen absorbed by the wort from the atmosphere, in the process of fermentation, and which in a state of combination, forms carbonic acid. If wort possessed a sufficient quantity of carbon to unite with the whole of the oxygen that must or may be derived from the atmosphere before vinous fermentation is compleat, in its first and second stage, the addition of hop extract would be unnecessary; but as it does not, the impartation should be proportionate to the extent to which that fermentation is intended, or is liable to be carried to. If such is not attended to, or the judgment fails in discriminating what should be the requisite quantity of Hops, to afford the necessary quantity of carbon, to combine with the oxygen that must or may be absorbed before such beer is consumed, then the oxygen absorbed after the stock of carbon is exhausted, goes to the formation of acetous acid, instead of carbonic.

Parsimonious motives may induce the long boiling of a small quantity of hops, instead of the short boiling of a large quantity, with a view to the obtainment of as much extract from the former as the latter; but this cannot be done but at the expense of obtaining a bad flavor, proportionate in extent to the improper time of boiling; for after Hops have yielded their fragrant bitter, any additional boiling will extract the terrene bitter, (which is nauseous to the taste,) proportionate

in quantity to the extra time and force of boiling. Those who have tasted the first and second or third products of an infusion of plenty of tea in boiling water against a small quantity of tea boiled in water; or again an extract obtained from coffee, by infusion in boiling water, against the product of coffee, long boiled in water, can well appreciate the probable correctness of my observations relative to long and short boiling of hops.

In determining what should be the quantity of Hops to be used in each Brewing, the judgment of the Brewer must be consulted on the following points. If they are new or old. Their present quality at the time of using, whether new or old. If possessing little or much of the essential or terrene bitter or both. The time it is intended to boil them. The circumstances under which the wort in which they are boiled, is likely to be fermented. The ultimate point to which it is intended to endeavour to carry such fermentation, either the foul or the transparent. The hop flavor required to be left on the different beers at the time of their consumption. To come to a right conclusion on these several points of consideration, upon each occasion of brewing, is perhaps impossible; but if so, yet it is quite desirable, that every Brewer should arrive at a correct determination as nearly as he can; and as uniformity in hop flavor, and quality of beer, is what the generality of consumers require, it should be the Brewer's purpose, by the obtainment of all available information, and close, attentive, and careful observation, to so regulate his practice, as to realise the required results, as far as they lay in his power to command them.

A small portion of this information, to such as need it, I will endeavour to supply, and it is for them by practice and observation to judge, if such as is furnished is correctly founded upon fact.

The finest flavor of Hops consists in an essential Oil, which is very volatile, and is soon lost by exposure to the atmosphere. Much care should be taken to prevent all unnecessary loss of it, by an adoption of the best means to prevent its access altogether, or as much as is possible, from the time they are gathered and dried, until the time of consumption. A great portion of this fragrant Oil may be lost in drying Hops on the Kiln; and this indispensably necessary process should be conducted so as to effect an evaporation of the juices which would cause a putrefactive fermentation if not got rid of, with as small a loss of the essential Oil as is practicable.

Conscious of the value of this Oil, and the importance of its preservation, as relates to the flavor and appearance of Hops; both the Grower and Factor adopt precautionary measures for its preservation, to an extent proportionate to their estimate, of the resulting advantages to themselves, in which they are governed also, by the time they expect to keep them before effecting sale.

The careful Grower dries them slowly on the Kiln, and to an extent sufficient to assure the required evaporation of moisture, without any unnecessary avolation of essential Oil; and packs them in thin canvass pockets, or thick bags, as custom, habit, opinion, or circumstances induce. He is also careful to have them well trod in, and such he conceives is enough to preserve them bright and odoriferous, until he can sell them; and all subsequent precautionary measures, with a view to preservation, he leaves to the purchaser to adopt or not as he pleases.

The Hop Factor often goes one step further, and with a view to prevent too great an access of atmospheric air, which would both injure the appearance and quality of the Hops he has purchased, he puts the

pockets or bags into a powerful press, and reducing their bulk, renders them less pervious to the air. But he generally stops much short of the point at which the Brewer should endeavour to reach; for as the latter purchases for his own consumption, and has often occasion to keep them for a very long period, he ought to go one step beyond the Hop Factor, and subject them to a yet powerful pressure, by which means, he will be enabled to nearly cover them doubly with canvass, after which he should cover them with a double coat of coarse brown paper pasted on, which will effectually exclude the air from them, and prevent the egress of the essential Oil. A great portion of the stock of Hops in the Brewery, in which I am now engaged, and all such as is intended for long keeping, have this season (1834-5), been so treated; two pockets of which I measured the length of, before and after pressing were 6 feet 10 inches previous, and 3 feet 4 inches subsequent. At the time I am now writing, June 24th, 1835, the pockets so treated have not been opened, the intention being to open one of the two alluded to, at the end of a year from the time of pressing, and the other at the end of two years, for the purpose of proving the value of the method by their then condition. The two pockets referred to, are Sussex, grown by F. Rich, East Hothly, and were pressed, &c. Oct. 30th, 1834. By a reduction of their length to one half, much room in Storage, &c. may be saved, and I am decidedly of opinion, that both Hop Factors and speculators in hops, would find the system most advantageous in many respects.

As it is necessary to choose Hops, that possess the largest quantity of essential Oil, and to endeavour by every available means to preserve it after purchase; so is it desirable to abstract it from the Hop and blend it with the wort on right principles, lest after it has been

judiciously purchased and carefully preserved, it may be injudiciously and carelessly lost.

Many Brewers boil their worts in an open Copper, and this Oil, which is extremely volatile, is to a considerable extent consequently lost. Some also infuse their Hops in hot water, previous to boiling, and as soon as the wort is in the Copper, add both the hops and the hop extract to it, and boil altogether.

Both in theory and practice this method appears to me to be highly objectionable; for as Oil will not blend with water without the intermediate agency of some other substance, if the essential Oil is extracted from the hops by such infusion, it must swim at the top, and a great portion of it be lost by avolation, and the fragrant bitter being extracted previous to boiling, the terrene bitter is the more liable to be extracted during the proper time of boiling. As Oils are miscible with water by the agency of sugar, so the essential Oil of hops is miscible with wort, by the agency of its saccharum; consequently the boiling of the Hops in the wort, ensures the best means of extraction and blending. I have known others, and have myself practised the system of obtaining hop extract by repeated infusions, and added it to the wort without boiling the Hops therein, for the purpose of preventing the loss of wort, which adheres to hops in the hop back; and to save the labour of pressing them, to obtain all the wort which is by such means practicable; and also from an idea that by not extracting any terrene bitter, the boiled wort would prove of finer flavor; but in practice I have found that the latter point is lost instead of gained, as such wort has always appeared to me to be destitute of that fine flavor imparted by the essential Oil, and the quantity of bitter extract obtained, insufficient from the same quantity of Hops, as will yield a sufficiency by moderate boiling. Such being the case,

the disadvantages more than counterbalance the advantages resulting from infusion.

Many Brewers prefer using yearling Hops to new, as soon as the latter are in the Market, under the idea that they impart a rank flavor to the wort, and allow them to remain some time before they begin to use them, waiting, what they deem, their amelioration by a lengthened exposure to the atmosphere, by the ordinary mode of keeping. And when they do begin to use them, it is generally with an admixture of yearlings.

Such a prejudice against the early and entire use of new hops, appears to me to be founded on the results which have been experienced, by the use of an improper quantity, and by overboiling. If in passing from the use of old Hops to new, the judgment is not governed by a discriminating experience, sufficient to determine the right quantity of each, prejudicial results must necessarily ensue; and the evil experienced may properly be attributed to the mind that directs their appropriation, rather than to the quality and condition of the hops.

The effect of the atmosphere upon Hops appears to me to be chemical and not mechanical. I conceive that the oxygen both in a state of simple and chemical admixture with atmospheric air, combines with the carbon of the hop, and forming a new compound called carbonic acid, which is converted into carbonic acid gas, by the addition of caloric, quits the hop; and this process continuing, its strength (so called) is momentarily diminished, and with a rapidity proportionate to the quantity, state, and temperature of the air, which has access.

If the essential Oil and bitter principle were swept off from the surface of the hop leaf, &c. by a current of air continually passing over it, the air would then mechanically effect by attrition, that which I conceive it

chemically effects by decomposition; and as hops closely packed, and kept in a room not subject to the access of air in currents, are continually deteriorating in quality, the presumptive evidence I think is, that the effect is chemical and not mechanical. But let the effect be produced in whatever way it may, the consequences are sufficiently evident as to induce a conviction of the propriety of precluding the access of air from hops during the time they are preserved for use.

The effect of the atmosphere upon the extract of hops, when blended with wort, which is subject to fermentation, is precisely the same, I conceive, as upon the dry hop, contained in the package; it is chemical and not mechanical. The oxygen, in a state of simple and compound admixture with the atmosphere, unites with the carbon of the hop, by the power of affinity; the united principles constitute carbonic acid, the union has caused the decomposition of the bodies with which the principles were previously united, such decomposition has liberated latent heat, and which becoming free and active, unites with the new compound, and converts the carbonic acid into gas, and this gas escapes by avolation.

Admitting the correctness of this opinion, it must be obvious, that the higher the temperature at which the process of fermentation is carried, the higher the temperature of the atmosphere surrounding the utensils, in which the process of fermentation is conducted, the more the atmosphere is charged with oxygen, combined with it in a state of simple mixture, the greater must be the loss of carbon sustained by the wort during such process: and the same observation applies to beer, after the termination of the foul fermentation, and during the whole of the transparent fermentation.

The obvious inference therefore to be drawn from this fact is, that the quantity of Hops, the time of boil-

ing, &c. should be proportionate to the intended mode of fermentation, to the heat and state of the atmosphere, at the time such process is conducted, the time and circumstances under which such beer is intended or is liable to be kept, the tastes and opinions of generality of consumers, and other considerations that might be enumerated.

To attempt to point out any definite rules for the guidance of others, whereby they may correctly decide what should be the proper quantity of hops used to suit all the variable circumstances, would be extremely absurd; I therefore content myself with the endeavour to awaken the attention of the reader to the fact, that there is ever an unceasing demand for the exercise of his judgment; and to furnish the assurance that nothing but his own personal observation and experience will enable him to decide for himself; and if my remarks are sufficient to assist his own efforts, the purpose for which they are written will be accomplished.

It is the practice of most brewers to determine on the quantity of hops they will use with a given quantity of malt, before they know what quantity of extract such malt will yield, and the whole quantity is by many put into the copper with the first wort, returned again into the second, and in some cases even into the third. To this method there are several objections, a definite quantity of hops to an indefinite quantity of malt extract, the surcharging the first wort with an immoderate quantity, the liability of overboiling so as to extract the terrene bitter by returning them to the second, and much more so if to the third wort; the impartation of the best bitter to the first, and the worst to the second wort, and the irregularity of the quantity imparted to either. In my practice I always first ascertain the quantity of malt extract contained in each wort, and administer the supply of hops proportionate in quantity to the amount of extract contained in each wort, and never boil the same hops twice, unless for store beer.

To aid such purpose, I find the following tables very serviceable:—

The quantity Hops to Boil, proportionate to the Density of the Wort, from 5 tenths of

Density of Wort, lbs. per Barrel.	5ths oz.			6ths oz.			7ths oz.			8ths oz.			9ths oz.			1oz.			1oz. 1th.		
	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th
1			5			6			7			8			9		1			1	1
2		1			1	2		1	4		1	6		1	8		2			2	2
3		1	5		1	8		2	1		2	4		2	7		3			3	3
4		2			2	4		2	8		3	2		3	6		4			4	4
5		2	5		3			3	5		4			4	5		5			5	5
6		3			3	6		4	2		4	8		5	4		6			6	6
7		3	5		4	2		4	9		5	6		6	3		7			7	7
8		4			4	8		5	6		6	4		7	2		8			8	8
9		4	5		5	4		6	3		7	2		8	1		9			9	9
10		5			6			7			8			9			10			11	
11		5	5		6	6		7	7		8	8		9	9		11			12	1
12		6			7	2		8	4		9	6		10	8		12			13	2
13		6	5		7	8		9	1		10	4		11	7		13			14	3
14		7			8	4		9	8		11	2		12	6		14			15	4
15		7	5		9			10	5		12			13	5		15		1		5
16		8			9	6		11	2		12	8		14	4	1			1	1	6
17		8	5		10	2		11	9		13	6		15	3	1	1		1	2	7
18		9			10	8		12	6		14	4	1		2	1	2		1	3	8
19		9	5		11	4		13	3		15	2	1	1	1	1	3		1	4	9
20		10			12			14		1			1	2		1	4		1	6	
21		10	5		12	6		14	7	1		8	1	2	9	1	5		1	7	1
22		11			13	2		15	4	1	1	6	1	3	8	1	6		1	8	2
23		11	5		13	8	1	0	1	1	2	4	1	4	7	1	7		1	9	3
24		12			14	4	1	0	8	1	3	2	1	5	6	1	8		1	10	4
25		12	5		15		1	1	5	1	4		1	6	5	1	9		1	11	5
26		13			15	6	1	2	2	1	4	8	1	7	4	1	10		1	12	6
27		13	5	1	0	2	1	2	9	1	5	6	1	8	3	1	11		1	13	7
28		14		1	0	8	1	3	6	1	6	4	1	9	2	1	12		1	14	8
29		14	5	1	1	4	1	4	3	1	7	2	1	10	1	1	13		1	15	9
30		15		1	2		1	5	0	1	8		1	11		1	14		2	1	
31		15	5	1	2	6	1	5	7	1	8	8	1	11	9	1	15		2	2	1
32	1			1	3	2	1	6	4	1	9	6	1	12	8	2			2	3	2
33	1		5	1	3	8	1	7	1	1	10	4	1	13	7	2	1		2	4	3
34	1	1		1	4	4	1	7	8	1	11	2	1	14	6	2	2		2	5	4
35	1	1	5	1	5		1	8	5	1	12		1	15	5	2	3		2	6	5
36	1	2		1	5	6	1	9	2	1	12	8	2		4	2	4		2	7	6
37	1	2	5	1	6	2	1	9	9	1	13	6	2	1	3	2	5		2	8	7
38	1	3		1	6	8	1	10	6	1	14	4	2	2	2	2	6		2	9	8
39	1	3	5	1	7	4	1	11	3	1	15	2	2	3	1	2	7		2	10	9
40	1	4		1	8		1	12		2			2	4		2	8		2	12	0

TABLE.

Density of Wort, lbs. per Barrel.	an ounce to 3 ounces, to a barrel of Wort, whose density is 1lb. per barrel.																	
	1oz 2th.			1oz 3th.			1oz 4th.			1oz 5th.			1oz 6th.			1oz 7th.		
	lb.	oz	th	lb.	oz	th	lb	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th
1		1	2		1	3		1	4		1	5		1	6		1	7
2		2	4		2	6		2	8		3	0		3	2		3	4
3		3	6		3	9		4	2		4	5		4	8		5	1
4		4	8		5	2		5	6		6			6	4		6	8
5		6			6	5		7			7	5		8			8	5
6		7	2		7	8		8	4		9			9	6		10	2
7		8	4		9	1		9	8		10	5		11	2		11	9
8		9	6		10	4		11	2		12			12	8		13	6
9		10	8		11	7		12	6		13	5		14	4		15	3
10		12			13			14			15		1			1	1	
11		13	2		14	3		15	4	1		5	1	1	6	1	2	7
12		14	4		15	6	1		8	1	2		1	3	2	1	4	4
13		15	6	1		9	1	2	2	1	3	5	1	4	8	1	6	1
14	1	0	8	1	2	2	1	3	6	1	5		1	6	4	1	7	8
15	1	2		1	3	5	1	5		1	6	5	1	8		1	9	5
16	1	3	2	1	4	8	1	6	4	1	8		1	9	6	1	11	2
17	1	4	4	1	6	1	1	7	8	1	9	5	1	11	2	1	12	9
18	1	5	6	1	7	4	1	9	2	1	11		1	12	8	1	14	6
19	1	6	8	1	8	7	1	10	6	1	12	5	1	14	4	2		3
20	1	8		1	10		1	12		1	14		2			2	2	
21	1	9	2	1	11	3	1	13	4	1	15	5	2	1	6	2	3	7
22	1	10	4	1	12	6	1	14	8	2	1		2	3	2	2	5	4
23	1	11	6	1	13	9	2		2	2	2	5	2	4	8	2	7	1
24	1	12	8	1	15	2	2	1	6	2	4		2	6	4	2	8	8
25	1	14		2		5	2	3		2	5	5	2	8		2	10	5
26	1	15	2	2	1	8	2	4	4	2	7		2	9	6	2	12	2
27	2	0	4	2	3	1	2	5	8	2	8	5	2	11	2	2	13	9
28	2	1	6	2	4	4	2	7	2	2	10		2	12	8	2	15	6
29	2	2	8	2	5	7	2	8	6	2	11	5	2	14	4	3	1	3
30	2	4		2	7		2	10		2	13		3			3	3	
31	2	5	2	2	8	3	2	11	4	2	14	5	3	1	6	3	4	7
32	2	6	4	2	9	6	2	12	8	3			3	3	2	3	6	4
33	2	7	6	2	10	9	2	14	2	3	1	5	3	4	8	3	8	1
34	2	8	8	2	12	2	2	15	6	3	3		3	6	4	3	9	8
35	2	10		2	13	5	3	1		3	4	5	3	8		3	11	5
36	2	11	2	2	14	8	3	2	4	3	6		3	9	6	3	13	2
37	2	12	4	3		1	3	3	8	3	7	5	3	11	2	3	14	9
38	2	13	6	3	1	4	3	5	2	3	9		3	12	8	4	0	6
39	2	14	8	3	2	7	3	6	6	3	10	5	3	14	4	4	2	3
40	3			3	4		3	8		3	12		4			4	4	

The quantity of Hops to Boil, proportionate to the Density of the Wort, from 5 tenths of

Density of Wort, lbs. per Barrel.	1oz.8ths			1oz9ths.			2 oz:			2oz.1th			2oz.2ths			2oz.3ths			2oz.4th		
	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th
1		1	8		1	9		2			2	1		2	2		2	3		2	4
2		3	6		3	8		4			4	2		4	4		4	6		4	8
3		5	4		5	7		6			6	3		6	6		6	9		7	2
4		7	2		7	6		8			8	4		8	8		9	2		9	6
5		9			9	5		10			10	5		11			11	5		12	
6		10	8		11	4		12			12	6		13	2		13	8		14	4
7		12	6		13	3		14			14	7		15	4	1		1	1	0	8
8		14	4		15	2	1			1		8	1	1	6	1	2	4	1	3	2
9	1		2	1	1	1	1	2		1	2	9	1	3	8	1	4	7	1	5	6
10	1	2	0	1	3		1	4		1	5		1	6		1	7		1	8	
11	1	3	8	1	4	9	1	6		1	7	1	1	8	2	1	9	3	1	10	4
12	1	5	6	1	6	8	1	8		1	9	2	1	10	4	1	11	6	1	12	8
13	1	7	4	1	8	7	1	10		1	11	3	1	12	6	1	13	9	1	15	2
14	1	9	2	1	10	6	1	12		1	13	4	1	14	8	2	0	2	2	1	6
15	1	11	0	1	12	5	1	14		1	15	5	2	1		2	2	5	2	4	
16	1	12	8	1	14	4	2			2	1	6	2	3	2	2	4	8	2	6	4
17	1	14	6	2		3	2	2		2	3	7	2	5	4	2	7	1	2	8	8
18	2		4	2	2	2	2	4		2	5	8	2	7	6	2	9	4	2	11	2
19	2	2	2	2	4	1	2	6		2	7	9	2	9	8	2	11	7	2	13	6
20	2	4		2	6		2	8		2	10		2	12		2	14		3		
21	2	5	8	2	7	9	2	10		2	12	1	2	14	2	3	0	3	3	2	4
22	2	7	6	2	9	8	2	12		2	14	2	3		4	3	2	6	3	4	8
23	2	9	4	2	11	7	2	14		3		3	3	2	6	3	4	9	3	7	2
24	2	11	2	2	13	6	3			3	2	4	3	4	8	3	7	2	3	9	6
25	2	13		2	15	5	3	2		3	4	5	3	7		3	9	5	3	12	
26	2	14	8	3	1	4	3	4		3	6	6	3	9	2	3	11	8	3	14	4
27	3		6	3	3	3	3	6		3	8	7	3	11	4	3	14	1	4		8
28	3	2	4	3	5	2	3	8		3	10	8	3	13	6	4		4	4	3	2
29	3	4	2	3	7	1	3	10		3	12	9	3	15	8	4	2	7	4	5	6
30	3	6		3	9		3	12		3	15		4	2		4	5		4	8	
31	3	7	8	3	10	9	3	14		4	1	1	4	4	2	4	7	3	4	10	4
32	3	9	6	3	12	8	4			4	3	2	4	6	4	4	9	6	4	12	8
33	3	11	4	3	14	7	4	2		4	5	3	4	8	6	4	11	9	4	15	2
34	3	13	2	4		6	4	4		4	7	4	4	10	8	4	14	2	5	1	6
35	3	15		4	2	5	4	6		4	9	5	4	13		5		5	5	4	0
36	4		8	4	4	4	4	8		4	11	6	4	15	2	5	2	8	5	6	4
37	4	2	6	4	6	3	4	10		4	13	7	5	1	4	5	5	1	5	8	8
38	4	4	4	4	8	2	4	12		4	15	8	5	3	6	5	7	4	5	11	2
39	4	6	2	4	10	1	4	14		5	1	9	5	5	8	5	9	7	5	13	6
40	4	8		4	12		5			5	4		5	8		5	12		6		0

TABLE

Density of Wort. lbs. per Barrel.	an ounce to 3 ounces to a barrel of Wort, whose density is 1lb. per barrel.																	
	2oz 5th.			2oz 6th.			2oz 7th.			2oz 8th.			2oz 9th.			3oz.		
	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th	lb.	oz	th
1		2	5		2	6		2	7		2	8		2	9		3	
2		5			5	2		5	4		5	6		5	8		6	
3		7	5		7	8		8	1		8	4		8	7		9	
4		10			10	4		10	8		11	2		11	6		12	
5		12	5		13			15	5		14			14	5		15	
6		15			15	6	1		2	1		8	1	1	4	1	2	
7	1	1	5	1	2	2	1	2	9	1	3	6	1	4	3	1	5	
8	1	4		1	4	8	1	5	6	1	6	4	1	7	2	1	8	
9	1	6	5	1	7	4	1	8	3	1	9	2	1	10	1	1	11	
10	1	9		1	10		1	11		1	12		1	13		1	14	
11	1	11	5	1	12	6	1	13	7	1	14	8	1	15	9	2	1	
12	1	14		1	15	2	2		4	2	1	6	2	2	8	2	4	
13	2		5	2	1	8	2	3	1	2	4	4	2	5	7	2	7	
14	2	3		2	4	4	2	5	8	2	7	2	2	8	6	2	10	
15	2	5	5	2	7		2	8	5	2	10		2	11	5	2	13	
16	2	8		2	9	6	2	1	2	2	12	8	2	14	4	3		
17	2	10	5	2	12	2	2	13	9	2	15	6	3	1	3	3	3	
18	2	13		2	14	8	3	0	6	3	2	4	3	4	2	3	6	
19	2	15	5	3	1	4	3	3	3	3	5	2	3	7	1	3	9	
20	3	2		3	4		3	6		3	8		3	10		3	12	
21	3	4	5	3	6	6	3	8	7	3	10	8	3	12	9	3	15	
22	3	7		3	9	2	3	11	4	3	13	6	3	15	8	4	2	
23	3	9	5	3	11	8	3	14	1	4		4	4	2	7	4	5	
24	3	12		3	14	4	4		8	4	3	2	4	5	6	4	8	
25	3	14	5	4	1		4	3	5	4	6		4	8	5	4	11	
26	4	1		4	3	6	4	6	2	4	8	8	4	11	4	4	14	
27	4	3	5	4	6	2	4	8	9	4	11	6	4	14	3	5	1	
28	4	6		4	8	8	4	11	6	4	14	4	5	1	2	5	4	
29	4	8	5	4	11	4	4	14	3	5	1	2	5	4	1	5	7	
30	4	11		4	14		5	1		5	4		5	7		5	10	
31	4	13	5	5	0	6	5	3	7	5	6	8	5	9	9	5	13	
32	5			5	3	2	5	6	4	5	9	6	5	12	8	6		
33	5	2	5	5	5	8	5	8	1	5	12	4	5	15	7	6	3	
34	5	5		5	8	4	5	10	8	5	15	2	6	2	6	6	6	
35	5	7	5	5	11	0	5	13	5	6	2		6	5	5	6	9	
36	5	10		5	13	6	6		2	6	4	8	6	8	4	6	12	
37	5	12	5	6		2	6	3	9	6	7	6	6	11	3	6	15	
38	5	15		6	2	8	6	6	6	6	10	4	6	14	2	7	2	
39	6	1	5	6	5	4	6	9	3	6	13	2	7	1	1	7	5	
40	6	4		6	8		6	12		7			7	14		7	8	

Being an advocate for the well boiling of worts, and as my practice is to boil the first wort 1½ hour, the second 2½ hours, or if the first and second are boiled together, from 2 to 2½ hours; I find such time quite sufficient to extract all the bitterness from hops that is desirable, as relates to flavor; but the short boiling and over charging the first wort which many practice, is certainly not sufficient to extract all that is desirable, and the return of the hops to the copper for a second boiling is a necessary remedy for the first error; but the prevention of an evil is better than its cure.

The utility of the tables will be perceived from the following directions for their use :—

Suppose the Brewer finds that the quantity and density of the first wort when down in the under back, or pumped up into the copper, is 33 barrels at 34lbs., and experience has convinced him, that for the particular brewing, 1oz. 5ths. of hops to a barrel of wort, the density of which is 1lb. per barrel, is sufficient. He then refers to the second table, and finds in the first column 33 bars. and in a line therewith in the 5th column under the head of 1oz. 5ths. he finds 3lbs. 1oz. 5ths. the proper quantity of hops for him to use to every barrel of such wort, he then multiplies the 33 barrels of wort by 3lbs. 3oz. of hops, and finds the product 103lbs. 1½oz. the quantity required for the first wort. Again, suppose his second wort consisted of 40 barrels at 24lbs. density; by reference to 24lbs. in the first column, he would find in a line therewith in the 5th column, under the head of 1oz. 5ths. the quantity per barrel 21lbs. 4oz. which multiplied by 40 barrels, gives 90lbs. of hops for the second wort.

On the supposition that the hops were found not of so good quality as expected, or that an increase in the heat of the weather, or other circumstances, induced the use of more; the small gradatory increase of one-tenth of

an ounce per lb. density of extract, as furnished by the Tables, will be found very serviceable in practice, as a guide to the judgment; and although the increase may seem ludicrously trivial, yet it will generally be found to be a sufficient gradatory increase from the Winter to the Summer months. An increase of one-tenth of an ounce, per lb. density of extract, on the two worts as before given, would amount to a difference of 7lbs. in the first wort, and in the second 6lbs.

In my own experience of trade, I have ever found that the success of a manufacturing establishment depends much, on not only the quality of the goods manufactured, but on the uniformity also. If uniformly bad, ruin soon ensues; if occasionally good and bad, partial success may follow; but if uniformly good, all other circumstances assisting, entire success becomes indubitable.

Before I quit this subject, I will briefly recapitulate, in a condensed series of maxims, that which I conceive is worthy of the attention of every brewer, as relates to the purchase, preservation, and use of hops:—for pale ales, brewed for prompt consumption, purchase a fine flavored, fragrant and well picked hop; for amber ale, the same requisites, with a little more strength; for porter—both running guile and store—and store ales, a strong hop, of as good flavor as can be met with: let either sort as soon as purchased, be pressed into a moiety of their original length, and covered with two coats of brown paper, pasted on the canvass, which in such case may be doubled; keep them in a dry, cool room, and as free as possible from the access of air, steam, &c.

Use them in quantity proportionate to the time and circumstances of the keeping of the beer, the system of fermentation, the habits and tastes of consumers, the variations of the seasons and the temperature of the atmosphere, and the varying quality of the hop, &c.

Never buy more than enough to last from one season to another, unless the price is so low, and the mode of preservation so good, as to justify the speculation. In my own practice I have found a pound of new hops yield as much and a more fragrant bitter than a pound and a half of yearlings. Never overboil your hops from parsimonious motives, for it will be found that a small quantity and good flavor is better than a large quantity and bad flavor. Let each wort receive its due portion of hops, according to its quantity and strength, and never boil them twice, unless it is for store beer, and even then there should be a judicious limit to the second boiling.

The hops which are boiled in a wort, necessarily absorb much of it, but the malt extract adhering to the leaf need not be lost but to a very small extent. The hops which are boiled in each wort should remain in the hop back, when withdrawn from the copper, and each succeeding wort which passes over them being weaker than the preceeding, a quantity of wort is left in them equal in strength to the last wort that passes over, and to prevent the loss of the whole of that, they should be well pressed. If in brewing I carry over a return wort for the following day's mashing, I cause such wort to be boiled for about a quarter of an hour, and a portion of it run off boiling hot upon the spent hops in the hop back, for the double purpose of extracting the wort of superior strength left in them, and to impart a portion of bitter extract as a preservative to the return wort; and by adopting this method, such wort may be kept perfectly sound until next morning, in the hottest weather, and until the third morning in winter, if requisite. Should such return wort be very weak, the value of the wort which may be obtained by pressing, will perhaps not be worth the labour of obtainment, but should it be strong, or should table beer be brewed after strong, the quantity obtained will

doubtless well repay the labour. After the hops have drained all night and lost much by evaporation, I have found that the average weight of dry hops put into the copper is about 190lbs., that will yield a barrel of wort, by pressing; and upon such data, calculation may be safely made in forming an estimate of the value of the produce, to set against the labor of pressing.

The Hydraulic or common screw press is sufficient for the purpose; but the more powerful the press, the greater will be the produce from a given quantity of hops; and if the press is necessarily small, the quantity pressed each time should be proportionate to the power. The receptacle for the hops may be a strong square box, with a false bottom full of holes, and a tap hole in the side of the box between the real and false bottoms, or it may be a well hooped wooden cylinder pierced full of holes, through which the wort will flow during the pressing, without either head or bottom, and placed on a stout piece of wood of a little larger diameter than the cylinder, and which piece will rest on another of still larger diameter, having a hole bored through in the centre, and the surface slightly hollowed out, so that all the wort that trickles down the sides of the cylinder, may flow to the centre hole, and from thence be received into a suitable receptacle beneath.

The internal surface of the cylinder should be plain and smooth, but longitudinal grooves should be cut in the external surface about a quarter of an inch in depth and about half an inch apart, and the holes should be pierced within the groove; by such means the wort passes uninterrupted by the hoops. When the pressing is finished, the cylinder is laid down on its side and both ends being open, the hops are punched out by an iron bar, but to obviate such labour, two semi-cylinders might be united by iron bands and screws or bolts, and when the pressing was finished, might be disunited by withdrawing the screws or bolts, and at once set the hops free.

CHAP. IX.

BOILING OF WORTS.

In this department of the process of brewing, as well as every other, the best informed brewer cannot but lament how small is his knowledge of the subject. How impenetrably closed are all the avenues that lead to direct, safe, certain and satisfactory conclusions as to the proper time of boiling, the evidences of sufficiency, or the proofs of insufficiency.

In the chapter on malting, I have stated that by an analysis of malt, its component parts have been found to consist of—

Gum	-	-	-	14
Sugar	-	-	-	16
Gluten	-	-	-	1
Starch	-	-	-	69
				100

Now if all malt invariably consisted of such proportions of such elements, much of the difficulty in the way of discovering a suitable length of time for boiling worts, would be removed. But as malt is found to vary much in the proportions of those constituent elements, and as by boiling, coagulation causes an abstraction of some part of them, we find that the difficulties in the way of appreciating a priori, how long worts should be boiled, or judging a posteriori, if worts have been boiled long enough, may be comprised under the following heads:—

If a brewer was capable of analysing a portion of every brewing of malt, and such analysis would furnish him with the correct proportions of the constituent parts of the whole grist, the process would, in various repects, be unsuitable to the pursuits and purposes of business.

If it were not so; then a knowledge of the proper proportions of those parts, to constitute the best malt, would be imperatively necessary to enable him to lay a foundation for the creation of a system of conducting every part of the process of brewing, on such principles as would ensure the production of the best beer, with the best malt.

Supposing it possible that he might discover an infallible system of producing inevitably a good beer from the best malt, and that he was conscious when he had the best malt to operate upon, founded upon his knowledge of its constituent parts, he would next have to discover if it was possible to pursue a variable system, that would ensure the production of good beer, from malt varying in a deviation from the right proportions of its constituent principles. Admitting the possibility of attaining a correct knowledge of the constituent principles of the malt to be brewed on every occasion, their several quantities, the proper standard of proportion, the extent of the deviations therefrom; the most suitable heat, quantity, and mode of application of the mashing menstruum, so as to extract right proportions from malt containing wrong proportions, then would there be the necessity of analysing each wort previous to boiling, to ascertain the relative proportion of principles they contained, with a view to regulate the process of boiling, for the purpose of coagulating the surplus quantity of the coagulable substance which the wort contained, more than was necessary for the production of good beer.

We will yet go farther, and imagine a brewer com-

petent to the accomplishment of all this, then he has next to contend with the difficulty of apportioning the speed and time of boiling, with that extreme degree of care and caution, so as with certainty to ensure a result conformable to previous calculation.

I trust enough, and much more than enough, has been said on this subject, clearly and indisputably to prove that no correct rule for the boiling of worts, as to the time requisite, can be given; and that every brewer must exercise his judgment in the best way he can, and expect very different results, and console himself with the conclusion, that where it is plainly evident the desirable knowledge of a subject cannot be obtained, we ought contentedly to put up with the case as it is. But though I advise contentment under circumstances, when insuperable difficulties prevent an avoidance, yet I strongly recommend a calm, dispassionate, and unprejudiced examination of them, previous to a conclusion that they are insuperable; and if they are deemed as not so, then to weigh the advantages that may result from successfully endeavouring to overcome them, against the value of the resources employed in the accomplishment.

I am aware that some will say, that in the case of boiling there can be no difficulty in the way of determining the proper time for each wort; and will point out, as the correct criteria for judging, the method of frequent examination of the wort, during the time it is boiling, in a glass, and if large flakes of the coagulable material of the wort are found to be formed, then an evidence is furnished that the wort is sufficiently boiled. Others will say, it is sufficient to boil the first wort half an hour; the second, an hour; and the third, two hours. Others will state that double and treble the time is requisite, and each party are well satisfied they

are right, and that their opponents in opinion are wrong. But what will say the enquirer after the truth of the case, when informed of so many discrepant methods? Particularly if he should venture to ask each informant for some satisfactory reasons for such opinion, and proofs indubitable of its correctness.

It must, I think, be evident to every intelligent and reflecting person, that the constituent principles of malt are not always in proportions the same, and that if they were, a variable method of extraction, would occasion an inequality in the proportions existing in the wort. That to constitute good beer, a wort should be perfect in its composition, previous to, or subsequently made so, by boiling, and that after boiling it should be subject to a perfect fermentation, and be uninjured by all extraneous causes, up to the time of consumption.

And to those persons who are conscious of all the prerequisites to the formation of good beer, it must be obvious, that they are unacquainted with the constituent principles of the malt they brew, as to quantity and correct proportions, that they are equally ignorant of the proper means to extract right proportions from malt which may or may not be composed of such as are right. That they are also ignorant, after they have obtained their extracts, what is their composition; and unacquainted with their composition, they as little know how to treat the product so as to ensure a good result.

If such then is a true and faithful delineation of the knowledge and information which all Brewers possess of the process of manufacturing Beer, and the materials from which it is brewed, (among whom is the present writer), well may it be asked, then, what is the utility of his writing upon a subject which he acknowledges he is destitute of much useful and desirable knowledge and information thereon?

To such a natural question my reply must be, that I profess to teach no further than I know, that my information is incomplete, that my object is to teach what I do know, and above all things to point out of myself that which I do not know, in order that others may learn, if they themselves do or do not know, that which appears to me to be requisite to be known, before any one can plume himself upon the acquirement of all that is desirable to be learnt, relative to the means of brewing good beer.

He that would be wise, must first know the boundless extent of his own ignorance. And true enough is the adage, that "the more a person knows, the more convinced he is of the very little he does know." And that excellent truism written by Pope—"a little learning is a dangerous thing,"—is as applicable to attainments in the art of Brewing, as it is to every department where much knowledge is requisite.

In confirmation of the truth of this statement, I think that I may safely appeal to the fact, that there are many who have been practical Brewers for a long period, who seldom, if ever, produce a good beer; who have ever adhered to an invariable system without deviation, such as they were first taught, and who believe it the best that can be taught, and who, if told they knew not how to brew good beer, would feel highly offended, and think the statement false. To such "a little learning is a dangerous thing." because they have not learnt enough to enable them to perceive their own ignorance, and, consequently, they do not endeavour to learn more, because they imagine they know enough. But to return to my subject; to form an estimate, whether or not worts are sufficiently boiled as evidenced by the apparent extent of coagulation exhibited by the appearance of the wort in a glass, appears to me to be a very fallible test. If all worts possessed

an equal quantity of the coagulable material, then might the practised eye of observation tell, probably, when the wort was sufficiently boiled. But as the first, second and third, or more worts, of two brewings, may not possess the same quantity of such material, but on the contrary, a very dissimilar quantity, an abstraction by coagulation to an equal extent, would not reduce the residue of the uncoagulated material to a state of equality; consequently, if one wort was in a perfect state for the process of fermentation, the other could not be. And if the quality of the beer was dependant on the residue left in the wort, and not on the quantity abstracted, where is the value of the knowledge acquired by observation?

And again: if the time of boiling is to be regulated by the criteria of coagulation, what is to be said relative to boiling, as regards the obtainment of a proper extract from the hops? If coagulation was to be the determinate criteria for boiling, the evidences in favor of termination, would be exhibited much earlier in the first wort, which needed the most extract of hops, than the second, which needed less; consequently, an adherence to the one system, would oppose the requirements of the other.

As relates to boiling by time, the preceding observations equally apply, and to which some additional objections may be urged.

But, before I point them out, let us examine the subject of boiling worts, as relates to the effect produced in fermentation, and analogy will best serve the purpose of illustration.

In the making of wine from the ripe grape as soon as gathered, or the dried grape, called raisin, if water is put to either, and after standing the usual time, the must is withdrawn from the husk without pressing the latter, and put into a cask, the fermentation will be slow and slight; but if the husk is pressed, and the

material, he must add to the artificial ferment already furnished an additional quantity, and if on the contrary he finds that he has underboiled, and has left in his wort too much of the fermenting material, he must adopt such methods to remedy the evil, as the reader will find more fully detailed in the chapter on fermentation.

To attempt to make wine or beer from sugar alone, would be an absurdity! but to make wine or beer by an admixture of sugar and the juice of fruits or vegetables, or sugar and the extract of malt, is both frequent and reasonable. Good malt contains a sufficiency of saccharum without the addition of sugar, but a wort from bad malt, will be improved by a judicious addition of sugar.

Enough has been said, I trust, to prove that no correct rule can be laid down to determine the proper time that worts should be boiled, or criteria furnished by which to judge, whether or not they have been more or less than sufficiently boiled, after such process has been accomplished; and it may by some be considered that at least an apology is due, for occupying so much of their time in proving what can be done, instead of shewing what can be effected. But to me it does not appear an apology is necessary, conceiving that where error exists, such a preventative to the attainment of a right knowledge should be removed, before the person labouring under its influence, can see the advantages of, or necessity for, the attainment of information; and what I cannot impart, they may endeavour to obtain elsewhere.

I will now close this chapter by stating, that in the absence of all means of judging what should be the proper time of boiling worts, or a knowledge of whether worts have or have not been sufficiently boiled, by any test after boiling, that I think it best to err on the safe side, by boiling rather too much than too little, and endeavour to obviate the defect on which soever side it

may happen, by a suitable management of the fermentation. And agreeable to such conclusions, I recommend one hour and a half's boiling for the first wort, two or two and a-half for the second, and from two to three for the third; or in case the first and second raw worts are boiled together, then two hours.

CHAP. X.

COOLING OF WORTS.

I am no advocate for the introduction of any new description of machinery, or the improvement of the old in a brewery, for the sake of mechanical advantages, regardless of the chemical consequences.

Various modes of cooling worts have been devised, some of which appear to me to be highly objectionable, while others appear to me to be very advantageous.

The old method of running the boiled wort from the hop back into shallow cooling backs, and there allowing it to remain until reduced in temperature to the point required, or to the heat of the atmosphere, appears to me to be objectionable for the following reasons: —

A great waste of time, even in the Winter; but more particularly in the Summer, is occasioned thereby.

A liability of too great an absorption of oxygen from the atmosphere, by so long an exposure to it, whenever such air holds the electric fluid in simple combination with it, which in hot and tempestuous weather it so frequently does. The impossibility of reducing the temperature of the wort to a sufficiently low pitching heat, when the temperature of the atmosphere is above the required heat.

An unnecessary waste of wort, by adherence to an unnecessarily extended surface.

Against these disadvantages I know but of one advantage as a set-off, which is, that in case your wort

should be of less than the required density, its density will be increased by the evaporation, consequent on the extension of surface and exposure to the air.

Some have adopted the use of a fanning machine, the objections to which appear to me to be—

The labour required to work it.

The greater liability of the wort absorbing oxygen, in consequence of the much larger quantity of air forced into contact with it, occasioned by the motion given to the air, and which by the fanners is caused to traverse over the surface of the wort, and sweep off the steam: and the extension of surface given to the wort, by agitation, occasioned by their use.

The beating into the wort of all insects and dust which come within the vortex of air, resulting from the revolution of the fanners.

The impossibility of reducing the temperature of the wort below the atmosphere, should it be desirable so to do in hot weather, for the purposes of fermentation.

Against these disadvantages, I know but of one advantage, which consists in being able to cool the wort in a less space of time, to the point required, or to the lowest, as is by such means possible, than can be by its exposure only in the cooling backs.

The next method to which I have to advert is the cooling of worts, by the medium of water, and which appears to me decidedly preferable to any other at present practised.

But there are a variety of ways in which the agency of water is used to effect the purpose; and which may be divided into four several principles.

To pass running wort through water in a quiescent state.

To pass running water through wort in a quiescent state.

To pass running wort through water, in a running

state, both wort and water running in the same direction.

To pass running wort through water in a running state, the wort and water running in an opposite direction.

As relates to either method, it must, of course, be understood, that some intervening substance keeps the wort and water from a state of union; and that through such intervening medium the heat of the wort is conveyed to the water.

Several methods have been devised, founded on each of these principles, to effect the desired object; but I believe it has been found that the fourth principle is the most efficacious, as to the attainment of the lowest temperature of the wort, the employment of the least quantity of water, and consequently with the greatest economy of labour.

One of the methods by which the first principle has been reduced to practice, (and which will serve to illustrate the result,) is to let the worts run from the cooling backs into the fermenting tun, through a metal worm, placed in a vessel of cold water, such as is used by distillers to condense the spirituous vapours proceeding from the still to the spirit receiver.

The objections to this method are: that by the impartation of heat from the wort through the metal pipe to the water in the worm tub, that the water would very soon be raised above the temperature at which the wort was required to run into the tun, and that it would not be possible to get the wort down into the tun at so low a heat as would be requisite, (let the quantity of water it contained be ever so great), in any thing like a reasonable time.

To elucidate this matter, we will suppose a medium case, of common occurrence in Summer:

A Brewer has forty barrels of wort to cool, which he

wishes to get down into the fermenting tun at 60 degrees of heat, but the temperature of the atmosphere about his cooling backs is 65 degrees of heat; consequently he knows well that while the atmosphere continues at that heat, let his worts remain exposed to it as long as they may, by its influence, he cannot accomplish his object. Again: he wishes to cool his wort to that point quickly, with a view to the saving of time, and to prevent the liability of the wort absorbing too much oxygen from the atmosphere. We will further suppose that he is of opinion that it would be prejudicial to his wort, to let it remain in the cooling backs beyond the time of its reduction in heat to 100 degrees, by its exposure to the atmosphere. Next: he has a worm tub, which he can fill with water immediately from the well at 50 degrees of heat; --the query is, how much water should his worm tub contain, so as to reduce his 40 barrels of wort to 60 degrees of heat, on the supposition that if the worm was filled, it would contain the 40 barrels of wort? and that the wort was allowed to remain in the worm sufficiently long, until, by the law of equalization, to which heat is subject, as much heat would be transmitted from the wort to the water, so that the temperature of the former would be reduced, and that of the latter increased to 60 degrees?

40 barrels of wort	160 barrels of water,
at 100 deg. of heat	at 50 degrees of heat
4000	8000
	4000
Divide by Barrels of wort and water	200)12000(60 degrees of heat
	1200
	0

Such an apparatus would prove very costly, and should

the brewer be of opinion that to let the wort lay in the cooling back, until reduced to 100 degrees was prejudicial, and that it ought to be got into the fermenting tun, before so great a reduction; the size of his worm tub must be increased in the ratio of his opinion, and should he have a second wort to follow the first, he might have occasion either partly or totally to re-fil it for a second operation.

It will be seen that I have exibited the use of the worm tub in its most expensive and objectionable state, and I will now point out its use in its cheapest and most advantageous—so far as outlay of capital is to be considered.

A worm tub and worm of less dimensions would be sufficient to accomplish the same purpose of cooling down to the same point, by continually pumping cold water into the bottom of the worm tub, and allowing an equal quantity of heated water to run out at the top, and letting the wort run into the tun, from the cooling back through the worm, at such a speed (to be regulated by a cock) as would ensure the temperature of the whole being got down at 60 degrees. It is true that by such a mode, a less sized worm tub and worm would effect the same purpose, but there would be the important objections of the brewer already stated; the greater time required, and the longer exposure to the atmosphere of a slowly, yet gradually, diminishing portion of the wort.

The second principle has been tested, by placing pipes in different modes of arrangement within the cooling backs, and causing water to pass through them, until the temperature of the wort was sufficiently low to get down into the tun. The objections to this method are, first—that it is not the most effectual and economical means by which the temperature of the wort may be reduced to the required point. Second—that an ex-

posure of the wort to the atmosphere in hot weather, is but injurious at the shortest possible period; and if continued during the whole process of cooling, is liable to prove seriously so. Thirdly—that if such pipes remain stationary in the cooling backs, an additional loss of extract is experienced, by the adhesion of wort to their exterior surfaces. And they may prove impediments to that indispensable cleanliness in which such utensils, as well as every other, should ever be kept in a Brewery.

The third principle has been exemplified, by placing one or more pipes, in a larger pipe, causing the wort to run through the inner pipe or pipes, and water through the outer one, both wort and water flowing in one direction. A little reflection must convince any one, that such a principle is erroneous both in theory and practice.

Let us imagine any number of feet (say 60) of wort, and water running in the same direction, of unequal temperatures, and seperated one from the other by metallic tubing, and subject to the law of equalization, the heat passing from the hottest fluid to the coldest, until both were of equal temperature. In consequence of the length of pipe being 60 feet, there might be sufficient time for the transition of heat from one to the other, until equality was established, but beyond that point, of course no further transition could take place.

If then the wort was at 100 deg. of heat, and the water at 50, and the volume of each the same, the mean heat would be 75 degrees, and if requisite to pitch the tun at 60 degrees, it would be necessary, at least, to pass through four volumes of water to one of wort. In figures four volumes of water to one of wort might appear sufficient, but in practice it would not be found so, under any other than very disadvantageous circumstances; and such proportions would of themselves be sufficiently inconvenient and costly.

The fourth principle is undoubtedly the best, and perhaps the only proper one to adopt. This, like the others, has been adopted under a variety of modifications, and I believe we are indebted to Mr. John Vallance, for the primary adaptation of this principle to the cooling of worts.

The mode by which this principle was first put into operation by him, has subsequently been much improved upon, as relates both to the cost of the apparatus, its efficiency in cooling with a reduced quantity of water, and by the appropriation of the water used in cooling, for the purposes of brewing, &c., instead of letting it run away to waste, as was formerly done.

To appreciate duly the value of the principle, an illustrative explanation to some may be necessary.

To simplify the subject, let us suppose that a pipe of one inch diameter and 41 feet in length is placed in the centre of a pipe of two inches diameter, and the same length. That the wort to be cooled is at 110 degrees of heat, and is required to be reduced to 60 degrees, by water at 50 degrees; and that the wort shall run down the internal pipe, and the water pass up the outer pipe. The wort decreasing in temperature one degree in every foot of its progress, and the water increasing in the ratio to the proportion employed. Let us further imagine that the internal pipe holds one barrel of wort, and the external two barrels of water, and on the supposition that the transmission of heat from the wort to the water was in arithmetical proportion, we should find the wort leave the inner pipe at 60 degrees of heat, and the water the outer pipe at 75 degrees.

The following diagram, divided into 41 parts, will, perhaps, exemplify the principle better than words:—

Some Refrigerators have been constructed in this way, but it is by no means the best method, although the simplest. Simplicity in machinery is often its best recommendation, but it does not apply as an invariable rule. To form a judgment of the difference in the effect produced between the inclosure of an inch pipe within a two inch, we have first to consider that the thickness of the metal with which pipes are made should be in proportion to the diameter of the pipe, consequently, as the one-inch pipe requires a thicker metal than the half-inch, the heat from the wort cannot be so easily and quickly transmitted through the inch pipe to the water, as it can be through the half-inch. Again: the heat contained in the centre of the wort, inclosed in an inch pipe, has half an inch to travel, each way, before it reaches the internal surface of the pipe; whereas, in the half-inch pipe, it has but the distance of a quarter of an inch. But a very proper objection may be urged to the use of a half inch pipe, enclosed in one of an inch diameter, for the cooling of worts, on the ground that such a refrigerator would be much too small for any Brewery.

But in the construction of a refrigerator of larger dimensions, the use of half inch pipes enclosed in one pipe of any given dimensions not less than two inches diameter, will be found to be the most efficacious and economical method of any. An evidence of the superiority of half-inch pipes, enclosed in pipes of different sizes, instead of an inch pipe in a two inch, may be seen by reference

to figures Nos. 2, 3, 4, 5, 6, & 7, in the first plate.

Figure 2, exhibits an inch pipe in the centre of a two inch.

Figure 3, exhibits five half-inch pipes within a two-inch pipe. Fig. 4, seven pipes in 2½ inch; fig. 5, eight pipes in 3 inch; fig. 6, twelve pipes in 3½ inch; and fig. 7, fourteen pipes in 4 inch.

The circumference of a pipe of one inch diameter is about three inches, and the circumference of a half-inch pipe is about one and a-half.

It will then be evident, that as the united circumferences of the five half-inch pipes in the two-inch pipe, presents a surface of seven and a-half inches, as a medium of communication of the heat contained in the wort to the water which encompasses them, and the one-inch pipe only presents a surface of three inches, that a third and very important advantage is presented by the use of half-inch pipes, as exhibited in figures 3, 4, 5, 6, & 7. In the first plate, fig. 8, represents a sectional view of a refrigerator, invented by myself, so far as an improvement on the refrigerators constructed under the directions of Mr. John Vallance (and the adherence to the principle which I before stated, I believe, he was the first to adopt) can be called an invention. Nor can I claim the priority in the inclosure of small pipes within a larger case, as the refrigerator in the Brewery in which I am now writing is composed of cast iron plates, enclosing copper (three quarter inch) tubes, the invention and construction of Mr. John Vallance, long before I thought of the appropriating them for the purpose; but yet I was not aware that their use had been adopted until about three years after the construction of my own.

Consequently all the merit which I can claim (if it possesses any title to the least portion) is the substituting copper external circular pipes, instead of flat iron or copper cases, and their appropriate connexion.

Reference to figure 8, *plate first.*- 1, 2, 3, 4, 5, 6, 7, 8, are eight copper pipes of any required diameter, not less than two inches; nor less length than eight feet. Each of these pipes contain half inch pipes, arranged as per figure 3, 4, 5, 6, and 7. The half inch pipes are soldered or brazed into a circular plate at each end, which plates fit into the end of the external pipes, and are soldered tight therein.

(A) Is a pipe conveying wort from the cooling back into the half inch pipes fixed in No. 8 pipe, and descending them, is conveyed into the first union pipe (C), and enters into the half inch pipes fixed in No. 7 pipe, and ascends therein, and from thence descends through pipes in No. 6, and so on, until it finally leaves by the pipe (B), by which it is conveyed into the fermenting tun.

(B) The pipe conveying wort from the refrigerator to the fermenting tun.

(C C) Union pipes which connect the pipes No. 1, 2, 3, 4, 5. 6, 7, and 8, together, and which are attached to the same, by brass union screws, (K K)

(D D) Are short pipes, which also connect the pipes, No. 1, 2, 3, 4, 5, 6, 7, and 8, together, and serve to convey the water from one to the other; which water surrounds the half inch pipes contained within them.

(E) A pipe from the water tank or the rising main of the pump, or connected with both; attached to the side of No. 8, pipe, and it will be perceived that this pipe, and the pipes (D D) and others, are united in the middle by union joints or flanges bolted, with a view to separation, in case of repairs, &c. being required.

(F) A pipe which conveys the water from the refrigerator to the water tank, or conveying it to the sewer, as may be most convenient.

(GG) Are air pipes of sufficient length to ascend a few feet above the cooling back, and are for the purpose

of allowing the air to escape from the refrigerator, when the wort is first turned on.

(H) Is an air pipe fixed into the water pipe of sufficient length to ascend a few feet above the water tank, and effects the same purpose to the water department, as the pipes (G G) do to the wort.

(I) Is a pipe leading from the water tank to the pipe (A) and is for the purpose of conveying water into the half inch pipes, after all the wort is run off from the cooling back, and those pipes are left full of wort. The purport of the admission of water on such occassion, is to expel the whole of the wort contained in the half inch pipes into the tun, which it effectually does with out admixture with the wort, leaving those pipes full of water instead of wort.

(J J) Stop cocks, fixed in union pipes (C C) for the purpose of drawing off the water from the half inch pipes.

(K K) Brass union screws, for the purpose of connecting No. 1, 2, 3, 4, 5, 6, 7, and 8, pipes together, affording the means of disconnecting the union pipes (C C), and thereby furnishing access to the open ends of the half inch pipes, for the purpose of cleaning them, or effecting any repairs, &c.

This refrigerator may be placed either in a vertical or horizontal position, whichever is most convenient; but the annexed view exhibits it in a vertical position, and in case of being placed in a horizontal position, the situation of the stop cocks (J J) the air pipes, &c. would require a modified arrangement.

The pipe (A) is connected with the cooling back, between which and the refrigerator may be a stop cock, or within the cooling back a valve.

The wort passes through this pipe into the refrigerator, and makes its exit at the pipe (B), which communicates with the fermenting tun.

The speed with which it will pass from the cooling back into the tun, when the stop cock or valve is fully open, depends much upon the height of the fall, or in other words the height of the wort in the cooling back, above the point of exit into the fermenting tun.

To regulate the temperature at which the wort shall come down into the tun, it is necessary to adjust a stop cock in the pipe (B) placed at a convenient distance from the tun, at any point as will govern the speed at which the wort may pass through the refrigerator. For this purpose it is usual for a person, by the aid of a thermometer, occasionally to ascertain at what heat the wort is in the tun, and also the heat of such as is flowing into it; and in case it has been, or is coming down too hot or two cold, then so to adjust the stop cock, as will allow the wort to run with less or greater speed, sufficient to ensure the required temperature; and a very little practice enables a person to get the worts down, at any given heat, with perfect accuracy.

The pipe (E) admits the water into the refrigerator, and by the pipe (F) it leaves it.

The pipe (E) should be connected with the liquor back, with a stop cock between; and, also, with the rising main of the pump, and a stop cock between.

By such an arrangement, the water may be pumped immediately from the well through the refiigerator into the liquor back, by opening the stop cock in the pipe connecting the rising main and refrigerator, and shutting the stop cock in the pipe connecting the liquor back with the refrigerator, by the pipe (E).

By this mode of operating, the refrigerator may be considered as but a tortuous rising main, and it will be found that but a very little more power is required to raise water from the well to the liquor back by such a route, than is by a straight and perpendicular rising main.

The advantages of thus raising the water through the refrigerator, to the liquor back, are three-fold.

The water being obtained immediately from the well, in which it is at about fifty degrees of heat all the year round, furnishes the means of cooling the wort quicker, and to a lower temperature in hot weather, than if it was first pumped up into the liquor back, and then allowed to run from thence through the refrigerator into a lower liquor back, or away to waste, because, in proportion to the time it lay exposed to the influence of the atmosphere in the liquor back, so would be its increase in temperature, until equality was realised. And should the heat of the atmosphere be at seventy degrees, or above, and the wort required to be got down at sixty degrees, it is plain that the water must be below sixty to accomplish it, and consequently must not remain too long exposed to such an atmosphere.

By this mode of raising water, the whole that is required for the purpose of cooling the worts may be saved, without the need of two liquor backs (one placed below the other), an advantage which needs not explaining, as relates to the outlay of capital and the saving of time, and horse, and manual labour, or fuel in case of the use of a steam engine as a motive power.

The third advantage is, that such water being saved, may be applied frequently to some beneficial purpose, with its temperature increased in the operation of cooling the wort, as it leaves the refrigerator at a heat in proportion to the quantity of water used to the wort cooled.

Between brewings, the refrigerator should be left full of water, both the wort and water compartments; unless in Winter, the refrigerator should be so situated as that the water may be liable to freeze therein; then in such case they should be left empty. In such case the opening of the cocks (J J) would serve to empt

the wort compartment, and a small cock might be inserted in the side of the lower end of each external pipe, for the purpose of emptying the water compartment.

Previous to commencing the cooling of the first wort of a brewing, the stop cocks (J J) should be opened, and all the water drawn off from the wort compartment. Then turn on the wort from the cooling back into the refrigerator, and as soon as it reaches the tun, ascertain its heat by a thermometer, and if too hot or too cold, regulate its speed by a proper adjustment of the stop cock in the pipe (B). And as soon as this process is commenced, as a matter of course, water should be pumped from the well through the refrigerator to the liquor back, or run from the upper liquor back through the refrigerator into the lower one.

The form of this refrigerator, the variable position in which it may be placed, the little room it occupies, its little weight, the facility with which it may be taken to pieces, cleaned, or repaired. Its effective powers, its small cost, and its value when worn out, or, if required, for an appropriation to any other purpose, renders it far superior to any other apparatus for a similar purpose that I have ever yet seen.

Before I quit this subject, I will state for the information of those who know nothing of the invaluable advantages of a refrigerator, that while I am now writing, a guile of ale is cleansing close to me– quantity, 68 barrels of XX, at a temperature of 66 degrees, which was pitched at evening 10, on the preceding day, at 62 degrees, the heat of the atmosphere surrounding the tun being then, and now is at 70 degrees, and the heat of the air above the coolers, at the time such wort was running therefrom through the refrigerator into the tun, was 76 degrees.

The weight of each of the refrigerators of the given

sizes, and the length of each case, nine feet, is from about 150lbs. the smallest, to about 750lbs. the largest.

The quantity of wort that each will cool per hour, upon an average, is from about eight barrels the smallest, to about twenty-five barrels the largest size.

As the variation in the price of copper is so frequent, and in different breweries the weight of pipe required may not be alike, no definite price for each size can be given, but it may be serviceable to say that the cost of six cases of each size would average from £40 to £90, and eight cases, from £50 to £120.

It must be understood that the weight and prices furnished refer only to the refrigerator, as delineated in plate No. 1, fig. 8, without any of the connecting pipes that lead to the several utensils, or any frame work to which it may be fixed.

As every case is connected together by union screws, they may, for the purpose of carriage, be detached and packed in wood altogether; the dimensions of the package for the largest size need not exceed in length 10 feet, in width 4 feet, and depth 1 foot, or width and depth 2 feet.

As relates to the quantity of wort that may be cooled by each refrigerator, no definite quantity can possibly be stated, as there are so many circumstances connected that militate against accuracy. Six cases in some breweries may do the work of eight in others, in the same time, resulting from the difference in the quantity and temperature of the supply of water, and the rapidity of the passage of wort resulting from the difference in the distance between the cooling back or hop back, and the point of delivery in the tun, in the several premises.

Also the difference in the facility of cooling in the cooling back, previous to, and during the process of, cooling by the refrigerator, and other causes in addition, which might be enumerated.

Although some brewers content themselves with the use of six cases, yet I strongly recommend eight to every one, because it is much better to be able to cool too fast than too slow, (not that the former is possible); and should one or two cases at any time need repairing, two can always be withdrawn for a short period, for the purpose, as they should be all made to fit in pairs.

As the refrigerator is subject to a considerable pressure, either if the water is pumped through it from the well to the liquor back, or if running through it from a vessel above the liquor back, into the liquor back, it is necessary that the pipes should be sufficiently thick, and the whole of the work well performed, so as to be able to support it: but, as the thinner the metal, the quicker and more effectual is the transition of the heat of the wort through it to the water, there must be a medium point of thickness best adapted for the double purpose. To state what that thickness should be, for every brewery, would be impossible, as the difference in the distance between the refrigerator and the liquor back, in different breweries, varies to a considerable extent; and as the pressure on the refrigerator is proportionate to the heighth of the point of delivery of the water into the liquor back, after it has passed through it, above the refrigerator; so any difference in the distance in different breweries, would give a difference in the pressure, and consequently cause a difference in the required strength of the metal.

As practice makes perfect, and the workman whom I first instructed to make them, and who has since made for several brewers, is become so prompt in the manufacture, and a competent judge of the requisite strength of pipe, &c. adapted to different premises, when informed of the particulars as before adverted to, I should conceive that, both for the superiority and accuracy of his workmanship, and moderate prices, he

would furnish a refrigerator of any size, better and cheaper than any inexperienced workman possibly could, from any description I have, or am capable of giving by drawing and description; and that as the weight is not great, such advantages would probably much more than compensate for the cost of carriage.

The facility with which this refrigerator may be cleaned, is also a very great recommendation to it. It may be performed mechanically, by taking off the connecting pipes (C.C.) and passing a brush attached to a wire rod or cane, through each half-inch tube, the mucilaginous coat, adhering, may be rubbed off, and afterwards well rinsed with hot water; or it may be chemically effected, by filling the refrigerator with boiling hot lees, as recommended for the seasoning, &c. of casks, &c. in chap. 18, but in such case, care should be taken not to let the lees remain too long therein, lest it dissolve the solder: two hours will be found sufficient; and such lees may then be drawn off by the cocks (J.J.) and returned again to the lime and ashes, through which by filtration it will pass, freed from impurity and be fit again for use. After the lees are withdrawn, it should be well washed out with hot water. It may also be cleansed by steam and subsequent rinsing.

CHAP. XI.

YEAST,

By analysis has been found to be formed of oxygen, carbon, hydrogen, and a very small portion of nitrogen.

In the production of beer, it is an agent by which a vinous, an acetous, or a putrefactive fermentation may be effected.

The desire and intention of the brewer doubtless is, or should be, to effect a vinous fermentation only, by its agency; instead of effecting a vinous and acetous, a vinous and putrefactive, or a vinous, acetous, and putrefactive fermentation, conjunctively, or an acetous or putrefactive, separately.

But the wish of the brewer is frequently not realised, through ignorance or culpable neglect, and seldom by unavoidable necessity, as relates to the effect produced by the agency of yeast.

Often, through ignorance, because he is not conscious that his yeast, which he puts into the tun, is in a state that will cause an acetous or putrefactive fermentation, or both, even if he examines it before using it; and often through culpable neglect, because he does not examine it before using it, and in sufficient time for the obtainment of better.

Often, through ignorance, because he is not aware of the proper means, by which yeast may be kept sound, and in fit condition for the purposes of fermentation from one brewing to another, or from culpable neglect,

because knowing the means, he fails to practice them, or having so failed, he does not obtain better from a more prudent brewer.

To preserve yeast sound and in good condition, from one brewing to another, less care is requisite in cold weather than in hot.

In cold or hot weather, the brewings should not be too far between; in hot weather the period should be shorter than in cold, for the utmost care exercised in the preservation is not sufficient to ensure good condition for a long period, and every day's keeping renders it of less value, and the sooner it is used, the more energetic and beneficial are its fermentative properties.

Yeast is in the fittest state for use, when taken up from the stillions, as soon as the fermentation is complete. It should be well freed from the beer, by draining, and the thicker it is when taken up, the better is its quality.

If it does not suit to use it at such time, it should be removed from the stillions, and placed in small quantities, and laid thin in wooden vessels, in a cool, dry, and airy situation, in order that it may not ferment. The temperature of the situation should by no means exceed 60 degrees, and as much lower as a suitable place can be found to place it in.

Necessity having never prompted, I have not tried an ice-well for the preservation of yeast from one brewing to another in sultry weather; but if an ice-well was dry and free from carbonic acid gas, I should imagine that it would be a desirable situation in which to place it, by those whose brewings were not frequent, who could not command a cool, dry situation on their premises to place it in, and who could not obtain a supply from others when in need.

Yeast should never be used in fermentation, that has spontaneously fermented, subsequent to its ejection

from the cleansing casks, as its fermentative powers have thereby been impaired, and an acetous or putrefactive fermentation must have commenced, and such yeast will communicate to the wort, with which it is mixed, a fermentation of the same character and extent, to which it had been previously subject.

Yeast should always be used by weight, instead of by measure.

The least quantity should be used, that is capable of effecting a fermentation to a given extent in a given time.

No definite quantity can be prescribed as proper to be used, inasmuch as a frequent variation is indispensably necessary, according to a variety of circumstances, of which every brewer should be fully aware, and capable of judging, which close and attentive observation and long experience will alone render him competent to. This subject I shall more fully enter upon, under the head of Fermentation.

A change of yeast is sometimes necessary, that is, yeast in good condition should be obtained of another brewer, for the purpose of fermentation, and the frequency of such obtainment should be in proportion to the need, of which the brewer should be a competent judge; for with the exercise of every care and caution in the preservation from one brewing to another, its fermentative powers will decline and wear out, and when such occurs, a change of yeast is as necessary to the brewer, as a change of seed is to the farmer.

The annexed Table, calculated for my own use, I have found highly useful, in conjunction with the dictates of my own judgment, in determinining the quantity of yeast to be used on every occasion.

Explanation relative to the use of the Table.—Suppppose that my judgment directs the use of four-tenths of an ounce of yeast to every pound density contained in the

YEAST TABLE.

Density of Wort. lbs. per Barrel.	The weight of yeast to pitch the tun with, in the ratio of its density.											
	7th. oz.		8ths. oz.		9ths. oz.		1oz.		1oz. 1th.		1oz. 2ths.	
	oz	th	oz	th	oz	th	oz	th	oz	th	oz	th
1		7		8		9	1		1	1	1	2
2	1	4	1	6	1	8	2		2	2	2	4
3	2	1	2	4	2	7	3		3	3	3	6
4	2	8	3	2	3	6	4		4	4	4	8
5	3	5	4		4	5	5		5	5	6	
6	4	2	4	8	5	4	6		6	6	7	2
7	4	9	5	6	6	3	7		7	7	8	4
8	5	6	6	4	7	2	8		8	8	9	6
9	6	3	7	2	8	1	9		9	9	10	8
10	7		8		9		10		11		12	
11	7	7	8	8	9	9	11		12	1	13	2
12	8	4	9	6	10	8	12		13	2	14	4
13	9	1	10	4	11	7	13		14	3	15	6
14	9	8	11	2	12	6	14		15	4	16	8
15	10	5	12		13	5	15		16	5	18	
16	11	2	12	8	14	4	16		17	6	19	2
17	11	9	13	6	15	3	17		18	7	20	4
18	12	6	14	4	16	2	18		19	8	21	6
19	13	3	15	2	17	1	19		20	9	22	8
20	14		16		18		20		22		24	
21	14	7	16	8	18	9	21		23	1	25	2
22	15	4	17	6	19	8	22		24	2	26	4
23	16	1	18	4	20	7	23		25	3	27	6
24	16	8	19	2	21	6	24		26	4	28	8
25	17	5	20		22	5	25		27	5	30	
26	18	2	20	8	23	4	26		28	6	31	2
27	18	9	21	6	24	3	27		29	7	32	4
28	19	6	22	4	25	2	28		30	8	33	6
29	20	3	23	2	26	1	29		31	9	34	8
30	21		24		27		30		33		36	
31	21	7	24	8	27	9	31		34	1	37	2
32	22	4	25	6	28	8	32		35	2	38	4
33	23	1	26	4	29	7	33		36	3	39	6
34	23	8	27	2	30	6	34		37	4	40	8
35	24	5	28		31	5	35		38	5	42	
36	25	2	28	8	32	4	36		39	6	43	2
37	25	9	29	6	33	3	37		40	7	44	4
38	26	6	30	4	34	2	38		41	8	45	6
39	27	3	31	2	35	1	39		42	9	46	8
40	28		32		36		40		44		48	

CHAP. XII.

FERMENTATION.

The theory of fermentation should be well understood by every brewer; and it is but of little service to know, and to carry into effect, a right process of extraction and boiling of worts, unless the subsequent and most important process of fermentation is conducted on right principles.

In fermentation, every brewer should have a purpose to effect, which purpose he should well comprehend, and know by what means he can accomplish it, nor fail to pay every attention to their use.

A theoretical knowledge of the process of fermentation must convince the possessor that no definite and invariable practical system can be prescribed for any one, because it is a chemical operation upon variable materials, with varying agents; and that to accomplish an invariable purpose, a continual variation in practice is requisite.

The purpose of every brewer, in fermentation, should be the production of such beer, as will most please the majority of his best customers; and, as a general rule, I think it will be found that the eye must be gratified by its brilliant transparency and mantling vivacity; the taste, by its grateful flavor, combined with a richness and fulness on the palate, declarative of a bounteous supply of malt and hop; and the nerves and mental sensations, by vigorous bracing and exhilerating excitement, resulting from a full measure of spirit.

If such are the standard qualities indicative of good beer, it becomes an important subject of enquiry to every brewer, how their presence may be commanded; not once, or occasionally, but all the year through, in every guile he may furnish to a public, that will admit of no excuse for their absence, let the seasons and circumstances be what they may.

However unreasonable and inexorable the public may appear to a brewer, who, consulting his own ease, would like to pace quietly along the same path that his predecessors have done; yet an intelligent and enlightened public, moving rapidly forward in the road of refinement, will soon leave such a brewer unsupported, if an aspiring competitor steps in to solicit its suffrages, who can and will endeavour to merit them.

The conditions to ensure a right vinous fermentation are: a wort properly extracted from good malt, and placed in the copper previous to the absorption of an improper quantity of Oxygen from the atmosphere; good hops in right proportions; boiled together a proper time; cooled to the right pitching heat in the shortest possible time; yeast added as soon as the worts are all in the tun, and in right proportions. Cleansing from the tun into fermenting casks at the proper period, and carrying on the residue of the fermentation therein, on right principles. What is right and proper in these several operations remains to be shown, as relates to that part which has not yet been discussed, and as well as an imperfect knowledge of the subject will enable.

A vinous fermentation of wort is effected by the impartation of yeast to it, and by its abstraction of oxygen from the atmosphere. The mode by which such abstraction occurs is produced by an affinity which exists between the carbon of the wort and the oxygen of the atmosphere: the latter, impelled by the power of attraction, leaving the ærial element to unite with the

carbon in the fluid. But the union does not take place without the carbon advancing to meet the oxygen, each principle obeying the law of attraction. These principles, in a state of union, are called carbonic acid. The consequence of such removal is the decomposition of the wort, and the liberation of caloric from a state of latency to activity. Thus rendered free, the caloric unites with the carbonic acid, and gives to it the properties of a gas, and the new compound is called carbonic acid gas.

The property derived from the union of the caloric is less specific gravity, and by virtue of such property, the united trio ascend through the denser medium by which they are surrounded, and in their passage heave to the surface, those floating particles of coagulated gluten which obstruct their course, and which, united together in a body, constitute yeast; and having thus mechanically caused their ejection from the wort, they wing their way as tenants of the air. By this beautiful law of nature is decomposition, and recomposition effected, both chemically and mechanically. The products of vinous fermentation are carbonic acid, alcohol, and yeast, neither of which existed in the wort previous to fermentation, although a portion of the ultimate principles necessary to the formation of each were present; yet was the process of fermentation needed to effect the attraction, appropriation, and union of such as were deficient, and the abstraction of such as were redundant.

The researches and discoveries of chemists, relative to the properties and chemical operation of yeast in the process of fermentation, appear not to have thrown any satisfactory light on the subject; and but little or no more is known, than that the impartation of yeast to wort is necessary to the commencement and continuation of a vinous fermentation; that the impartation of

a small quantity causes the production of a large quantity; that good yeast is indispensably requisite to produce a good fermentation; that the larger the quantity of good yeast which is imparted, the more rapid, and to the greater extent, is the process of decomposition and recomposition effected, the temp e-rature of the wort to which it is imparted being the same; and that a small quantity of yeast added to a wort at a high temperature, will do as much or more than a large quantity to a wort of low temperature. And these are facts which every brewer should know, in order that he may the better be enabled to command a product in fermentation, agreeable to his views and wishes.

It has been ascertained that if yeast is added to wort in vacuo, that no fermentation will occur, but that as soon as atmospheric air is admitted, fermentation will take place.

As the composition of atmospheric air is 28 parts of oxygen, and 72 parts of nitrogen, there is no reason to suppose that its decomposition occurs to a sufficient extent to supply the immense quantity of oxygen that is requisite to form part of the compounds, carbonic acid and alcohol, created by fermentation.

The ultimate principles of which alcohol is composed, agreeable to the analysis of Saussure, are—

Carbon	- - -	52,17
Hydrogen	- - -	13, 4
Oxygen	- - -	34,79
		100,00

By the process of fermentation, it is well known, and established as a rule for computation by the Excise and others, that every 5lbs. density of attenuation, yields one gallon of proof spirit; or, to render it more intelligible, that if a barrel of wort, at 30lbs. density per

barrel, was, by fermentation, attenuated so low as to weigh no more than a barrel of water, the quantity of proof spirit created by such fermentation, (and which fermented wort would yield by distillation), is six gallons, as is indicated by dividing 30lbs. by 5lbs.

Without calculating the quantity of atmospheric air that must be decomposed, to furnish the supply for so great a demand of oxygen in the formation of the two compounds, carbonic acid and alcohol, it must, I think, be plainly evident that the supply of oxygen by the air, is not wholly, (and perhaps not partly), by its decomposition; but that the impartation occurs from such as is combined with it in a state of simple mixture. And to elucidate the case, we again find the results of scientific research, furnishing the valuable and satisfactory information, which not only leads to right conclusions, but to those which are serviceable also; inasmuch as a brewer, who is conscious of the fact, may resort to such means as are best calculated to ensure a sufficient impartation, and not beyond.

All substances upon the surface of the earth, in a state of decomposition, furnish to the atmosphere, (as a general rule), their constituent principles, which float in it in a state of simple mixture, until abstracted therefrom, by attraction resulting from the power of affinity; and as oxygen forms one of the component principles of many substances, the quantity in such a state of admixture, derived from such sources, is very considerable. But the greatest supply is from vegetables in a state of growth, and at a time when the vital powers are in a state of energetic activity. From the research of science we learn, that a large quantity of oxygen transpires from the surface of leaves of plants and trees in the day time, and carbonic acid in the night; and from a knowledge of this fact, it enables us to account for the cause of fermentation being more rapid

and to a greater extent in the spring and summer, than in the autumn and winter, separate and independant of an increased temperature of the atmosphere, which, although it aids and accelerates the impartation, is by no means a primary, but a secondary cause.

Thus far we have arrived at the theoretical and practical conclusion, that the impartation of oxygen to wort, and in large quantities, is necessary to ensure vinous fermentation; that yeast is a needed, but subsidiary agent; that the better the yeast, and the larger the quantity imparted, so is the liability of the impartation of oxygen being greater: that heat facilitates and promotes the impartation of oxygen, and therefore the higher the temperature at which a wort is pitched; and the atmosphere that surrounds it, the greater is the impartation of oxygen to it; that heat promotes combustion, and heat, and light, the transpiration of oxygen from the surface of leaves of plants and trees, consequently in warm weather, not only is the quantity of oxygen floating in the atmosphere greater than in cold, but the facility of impartation is increased. Again we conclude, that as the vegetable functions of life, are on the decline in autumn, and dormant in the winter, (as a general rule), and are in full vigour and activity in spring and summer, that during the months of the latter the supply of oxygen to the atmospaere is much greater than in the former, therefore, (as a general rule), fermentation must necessarily be more rapid and extensive, at such period. That such is the case, is the conviction of my own mind, founded upon the results of enquiry, experiment, and observation.

Popular proverbs induce the conclusion, that the maxims and information which they are intended to convey, are founded in truth; because as one of those proverbs state, " that what every body says is true, it

must be so;" but the best reason to be assigned for our giving implicit credence to the truth intended to be conveyed thereby, without investigating the subject, and judging for ourselves, is, that it is a truism so palpably plain and self-evident, and has passed the ordeal of so many person's judgments, and run current for so long a period, that although no one can furnish irrefragable proof in support, yet are we inclined to take it upon trust that it is so, without requiring any demonstration to induce conviction.

Among proverbs of this class, is one connected with our present subject, that "March and October are the two best months for brewing in." And why have we so long believed it? Because it is a proverb;—and those who have had no means of practically judging, take it for granted that it is true; and those who have, may have, or imagined they have had convincing proof in practical results. Now let us take this proverb, which I hold to be good as a general rule, and compare the assertion made by the formula, and conditions of fermentation, which I have ventured to furnish, and see if we cannot discover a reason, why these two months are the best in which to brew, or in other terms, in which brewers, brewing with or without rule or system, conscious or not conscious of the nature and operation of existing causes and resulting effects, can produce beer of the best quality, and that will keep sound the longest. The best beer! What are the requisite qualities?—I have already described them:—That will keep sound the longest! What are the conditions? Good qualities as described, and freedom from acetous acid. But why is the presence of one and the absence of the other best secured in those two months? Because the atmosphere is then charged, (as a general rule), with a medium quantity of oxygen, vegetation being on the decline in October, and in its commencement in March;

and, consequently, such as brew and leave fermentation to take its course without controul, experience a good result from natural causes; and such as attempt to exercise a discretionary judgment, find natural causes co-operating favorably with their intentions; and having nothing to contend against, can ensure their purpose, with scarcely an effort to accomplish it.

Thus far, I trust; I have succeeded in establishing a basis for the erection of a standard of right fermentation, by the aid of general consent, founded on common observation and experience, as relates to results, and by demonstrative proofs, as relates to causes.

We have next to consider what is the effect produced in fermentation, when the atmosphere is chargéd with a medium quantity of oxygen? The obvious reply, I think, should be, to cause attenuation to proceed to a medium extent: and such a result, as far as my own experience goes, will best accord with the conflecting claims of the eye, the taste, and the feelings of the public, furnishing transparency, fulness, and a sufficiency of spirit, blended in harmony and right proportions, and accomplished by a correct combination of the oxygen imparted, with the carbon of the wort, creating carbonic acid instead of acetous acid.

The next point of consideration is, what is the effect produced in fermentation, when the atmosphere is charged with so small a quantity of oxygen, that the impartation is not sufficient, without the aid of extraordinary agency, and when such means are not attended to, from carelessness or ignorance? The answer, again, I think, should be, that attenuation is not carried to that point, where transparency, with or without finings, will ensue, decomposition having feebly commenced, and the power (carbonic acid gas) to throw off the excretory results, not having been created to a sufficient extent, nor endued with sufficient vigour;

therefore the eye is not satisfied: nor is decomposition sufficiently effected as to take off the excessive sweetness and fulness which cloys upon the palate, and the presence of carbonic acid being insufficient, from an inefficient production, no alloy is furnished to ameliorate the sickening mawkishness.

And such beer produces not a sufficient stimulus to brace the unstrung nerve, or exhilarate the depressed spirits of an exhausted consumer, and is also but ill adapted to sound continuance; for as the foul fermentation ceases before decomposition has made much progress, and is effected in cold weather; as soon as such beer is exposed to an atmosphere of high temperature, and replete with oxygen, it becomes subject to a second fermentation, in consequence of the large residue of fermentable materials left undecomposed; and not being furnished with a fresh supply of yeast to direct a right appropriation of the oxygen imparted, so as to create carbonic acid, the production of acetous acid necessarily ensues.

From the last point, let us turn our attention to the opposite, and enquire what is the effect produced in fermentation, when the atmosphere is charged with more than a medium or an excessive quantity of oxygen? To this question, I conceive, the replication must necessarily be, that attenuation is consequently carried beyond that point where transparency naturally or artificially ensues, because when the presence of oxygen in atmospheric air is most abundant, the procuring cause, caloric, is also most abundant; and as the latter is an agent of communication of the former, the agent assists the impartation of the oxygen which causes both rapid and extensive decomposition, and retards the rejection of the excretory materials, carbonic acid and yeast; for as the atmosphere of high temperature is of less specific gravity than that which

is of a low temperature, the capability of carbonic acid, (whose specific gravity is greater than atmospheric air, until converted into a gas by a large quantity of caloric) to raise to the surface the coagulated gluten, and to leave itself the wort, is diminished. The consequence is an extensive demolition, unaccompanied by the necessary powers to complete the excretory process, and the eye is offended by the consequent appearance. Nor is the palate less so; for, independant of the ill flavor which the foul remains communicate; the absence of that fulness and sweetness which the unfermented extract furnishes, combined with the lively piquancy which carbonic acid yields, defrauds the palate of its accustomed due, and in vain would be the pleading of the brain, that what the palate lost, it had gained by a consequent increased supply of spirit; for if morality sat as judge between the two, the decision would surely be in favor of the first recipient.

I have before stated, that in fermentation every Brewer should have a purpose to effect; and I have endeavoured to shew that a medium fermentation produces the best results, and it must therefore be evident that such medium is the purpose I recommend. I have endeavoured to point out the obstacle in the way of attainment thereto, in Autumn and Winter, and the accelerating cause to urge beyond it, in the Spring and Summer; the ultimate principle of causation, and agents of its accomplishment at all times, and suggested the increase or diminution of the agency, when the ultimate principle of causation is defieient or in excess; and the next point of enquiry which naturally presents itself, is—What is a medium point in fermentation, and will the attainment to that point furnish Beer of the most satisfactory quality?

As relates to my own experience, founded on close and attentive observation, an attenuation to a moiety

of the original density, in Autumn and Winter, and a little beyond in Spring and Summer, is that desirable medium that will best ensure transparency, fulness, and present and future soundness, combined with the production of a moderate portion of spirit; and although in recent practice, both in Winter and Summer, I have found Beer, so far fermented, has given more satisfaction to the generality of consumers, for whom I have brewed, and which, as Store Beer, has kept the soundest; yet I am fully aware that such a practice will not produce a beer that will please every one, and would be by no means a suitable point of purpose, to many brewers, whose customers have been habituated to beer of lower attenuation. In fact, for that portion of the public I am now brewing for, beer attenuated to no lower than a moiety, would, a few years ago, have been distasteful to, but a gradually increasing disposition for a full rich beer, has induced me as gradually to raise the standard point, to which I endeavour to attenuate.

To others, therefore, I should strongly recommend, that their first endeavours should be directed (in case it has not been) to the obtainment of a knowledge to which point it is necessary they should attenuate, to give most satisfaction to the majority of their customers; and this is easily effected by the aid of the saccharometer in ascertaining the density of Beer, at the termination of the foul fermentation, if sent out as soon as it is completed; or previous to sending out, if kept in store any length of time after brewing.

Having ascertained the point of attenuation at the time of consumption, at which beer will best suit the taste of the generality of consumers, let him make it a standard point for the time being, or until public opinion changes, and next direct his attention to the means of attainment, without exceeding.

But the obtainment of a knowledge of what should

be the right point of attenuation, is much easier than an attainment to it, and not beyond, in practice ; and easier to arrive to, than to stop short at, as the following results of 100 successive Brewings of Ale, at about 32lbs. original density, with every effort made to attenuate to no lower a point than from about 12lbs. to 16lbs. will evince.

			lbs. lbs.
In 4	Brewings the attenuation	from	8 to 9 per barrel.
15	ditto	- -	9 to 10 ditto.
15	ditto	- -	10 to 11 ditto.
9	ditto	- -	11 to 12 ditto.
10	ditto	- -	12 to 13 ditto.
17	ditto	- -	13 to 14 ditto.
12	ditto	- -	14 to 15 ditto.
10	ditto	- -	15 to 16 ditto.
8	ditto	- -	16 to 17 ditto.
100			

Yet it does not follow, that because attainment is difficult, or at all times impracticable, that an endeavour to accomplish it is not advantageous, for whatever may be the point determined on, the nearer the approximation in attainment, the more satisfactory will prove the result.

I have before stated that the cause of vinous fermentation, as a principle, is the impartation of oxygen ; that the source from which such oxygen is derived for the purpose, is the atmosphere ; that the state in which such oxygen is combined with the atmosphere, is simple mixture ; that its admixture therewith is in variable quantities throughout the year, but that as a general rule, it is much more abundant in spring and summer, than in autumn and winter. That the necessary agents to ensure vinous fermentation are caloric and yeast ; and to ensure an attenuation to a right point, temperature in atmosphere, and in wort, and quality and quantity of yeast, are so many points of consideration that must operate on the judgment of the brewer, in determining the heat at which he will pitch his tun, the obtainment

of good yeast, and the administration of the quantity. He cannot regulate the supply of oxygen to the atmosphere surrounding his wort during fermentation, nor the impartation to it, agreeable to his will; nor can he determine the temperature of the atmosphere, or prevent its changes to suit his purpose: all he can do is to pitch his tun at such a heat, select such yeast, and impart in such quantity, as he thinks is best calculated to effect his object, and to regulate his system of cleansing and filling up, &c. agreeable to circumstances, and the dictates of his judgment.

To succeed well in such an undertaking, requires long and continued practice, accompanied with a knowledge of all the difficulties to contend with, and a determination patiently and perseveringly to combat them; and personal experience, founded upon close and attentive observation, will prove far more instructive and serviceable to the practitioner, than any verbal or written practical instructions that can be furnished by another; but still the person who has already trod such a devious path, may render another, who may have to tread, (though not the same, yet one as intricate), some general information, which may assist him on his way, and for such purpose, I will endeavour to furnish all that I am able.

The heat of the the tun and cleansing rooms, during the time the 100 brewings referred to were in process of fermentation, varied from 42 to 74 degrees. The pitching heat of each wort varied from 59 to 64 degrees. And the quantity of yeast pitched with, varied from 2 tenths to 5 tenths of an ounce per barrel of wort, at a density of one pound per barrel.

In every part of the year, and in the coldest of weather, the atmosphere ever possesses a sufficiency of oxygen, to cause an attenuation of wort, to any point required; and all that is requisite for the brewer to

perform is, to ensure a sufficient impartation, by pitching his tun at a suitable temperature, and by the addition of a suitable quantity of good yeast.

In the temperate months of the year, a medium pitching heat and quantity of yeast is required.

In hot weather and at that time of the year when vegetation is in full vigour, a low pitching heat, and a very small quantity of yeast, is preferable.

At the present time, E 6. July 21st, 1835, while I am writing: a wort of about 50 barrels, and at 32lbs. density, is passing through the refrigerator into the tun, at 60 degrees of heat, at which I intend to pitch at, and the temperature of the atmosphere in the tun room is 74 degrees. I intend to pitch with the smallest quantity of yeast, I ever yet did, in the ratio of 1¾oz. of yeast, per every pound density of extract contained in the wort, which, on the supposition that the quantity should be just 50 barrels at 32lbs. per barrel, will amount to 17½lbs. of yeast.

The attenuation of such wort, I expect will be much below my standard point, and I should use still less yeast, but from an apprehension that an acetous fermentation might occur, instead of a vinous, if the biting of the yeast should be protracted for too long a period: but upon this part of the subject, I have not yet obtained that experience, which I am still seeking; and to ascertain the smallest quantity that may safely be administered, I am progressively, yet gradually, reducing the quantity each brewing, until a minimum point is attained to.

In such weather brewers cannot be too careful in adopting every precautionary means to preserve their yeast for pitching in good condition, from one brewing to another, and if they are sufficiently close together, it is better to use yeast that is light and fresh, rather than solid and stale; but if choice enables, its best state for

use is, as soon as fermentation is complete, and the trough beer is withdrawn thoroughly from it, which latter point should be well attended to, otherwise beer being weighed for yeast, expected results may not be realised. Should spontaneous fermentation have occurred, or should there be the slightest appearance of acidity or putridity in the store yeast, a supply from another brewer should immediately be obtained; and whether such has occured or not, an occasional change is necessary throughout the year, and frequently during the spring and summer months. When a change of yeast is made, its effective powers are at a minimum, and therefore a somewhat larger quantity may be administered; and observation will evince that after such change, if the yeast is well kept from one brewing to another, its effective powers gradually increase, until a maximum is attained, and gradually diminished to a minimum, and before such point is reached, another change should be made. The time and circumstances under which cleansing from the tun into casks should be effected, are variable. The purport of cleansing, is division of the wort, to prevent too great an accumulation of heat, by decomposition of the wort in the tun, whereby fermentation might be accelerated to an improper state, and to enable the ejection of the yeast, which can be effected from the cask with more facility and advantage than can be from the tun, by skimming or any other means.

As acceleration is sometimes desirable, and at other times retardation as much so. The brewer must be governed by those circumstances that induce late or early cleansing, and with or without rousing previous to cleansing, as his judgment dictates the most desirable; and the then temperature of the cleansing room, or what it probably may be during the time of its fermentation in the cask, should be a subject of consideration.

No certain rule or system can be furnished by one person to another, that can advantageously be adopted, as no person ought to adopt an invariable practice, relative to cleansing. In my own practice, when acceleration is necessary, I suffer the wort to remain in the tun until the head has assumed a brown, close, and compact appearance, (the next stage beyond the rocky head), and cleanse previous to the head falling, with the temperature of the tun raised about six degrees above the point of pitching; and at the time of cleansing, rouse well, with a view to give an impulse thereby to the fermentative action, that may serve to counteract the chilling effect, resulting from the removal of the wort into casks of a lower temperature than itself, and in some measure subject to a loss of heat, in its transition thereto. But as in warm weather, or when the atmosphere is replete with oxygen, no stimulus is needed, I cleanse earlier and without rousing, and while the tun bears a rocky head. If the old mode of fermenting in the cask is practised, I cause the filling up from the troughs to be attended to every four hours at the commencement, gradually extending the intervals until fermentation has nearly ceased, when the latter fillings up are from fine beer of the previous brewing. But I prefer fermenting in casks, upon the self-filling principle, and have contrived a method as shown in plate the 2nd, which exhibits a sectional view of a row of bell casks, with the heads inserted a sufficient distance within each, to leave room for as much yeast as will be ejected from the wort within. The tin or copper tinned tubes of two inches diameter, which are fixed in the centre of the head, convey the yeast into the upper compartments, and the small holes of a quarter of an inch diameter, in the side of each tube, and one inch above the head of the cask, communicating with the half-inch tube descending to near the bottom of the

cask, is for the purpose of keeping the lower compartment of the cask constantly full of wort, a sufficient supply of which for the whole fermentation is left in the upper compartment above the hole in the side of the tube at the time of cleansing. A large hole is made in the centre of the head of the cask, for expeditious filling at the time of cleansing, and for the facility of well cleaning, subsequent to fermentation and racking. Such opening is accurately closed with a moveable piece of wood, in the centre of which is affixed the tubes described. A small cock is inserted in the side of the cask, close to the upper surface of the head, for the purpose of drawing off the beer left in the upper compartment after the fermentation is finished, and the yeast, being left dry, may be taken up as convenient. It will be perceived that a stillion in such case is not absolutely necessary, and that the casks may stand upon a stollage, but I prefer a stillion beneath, as in case of a violent fermentation, if the upper compartment of the cask will not contain all the yeast ejected, the surplus may be put into the stillions if preferred, and it also proves serviceable as a receptacle for the beer left in the upper compartment, after the fermentation is completed, where it may lay for the purpose of depositing a portion of its yeast, previous to being drawn off into casks, ready to be broke into the tun of the succeeding brewing.

The purport of the half-inch tube descending near to the bottom of the cask, is to convey the filling up beer immediately to the bottom, instead of allowing it to find entrance at the top, which, if permitted, would have the effect of precipitating the floating impurities, and retard, if not prevent their ejection; for, as such filling up wort must be reduced in temperature below the wort in the lower compartment, while it lays in the upper, exposed to an atmosphere of lower temperature

than itself, it becomes of greater density than the wort within the lower compartment, and consequently, if finding entrance at the top, it will necessarily descend to the bottom, carrying down every particle before it, whose buoyancy was not sufficient to resist its course.

This system of fermentation, which may be termed self-acting, will not only save much labour, both day and night, as well as waste, which occurs in the usual mode of filling up every four hours, but it saves the necessity of night access to the premises by workmen, and all the consequences, as well the liability of their neglecting the filling up at the proper period during the night. In the autumn and winter, the system will also be found preferable to the old method, inasmuch as the fermentation can better be conducted to the right point of attenuation, as no chilling check is given to the wort during the whole period, equal to the old method of filling up; in this case, the filling up being incessant and in small quantities, but in the other at long intervals, and in large quantities.

By the old mode of fermentation, the beer ejected from the bung-hole of the cask with the yeast, flows in a thin, continuous frothy state, into the stillion, subject to the abstraction of its heat, by the atmosphere to which it is exposed, in an extensive surface; it also lays subject to a considerable diminution of heat for a long period in the stillions, and is then pumped in large quantities into the bung-hole of the cask, causing the same injurious effects, as it is the purport of the half-inch tubes to prevent.

The following dimensions and content of a bell-cask, fitted up on this plan, may be of service to the reader:— Top diameter, 25in. 5ths.; bottom diameter, 19in. 5ths; depth between the inner surface of the bottom and head, 27in.; thickness of head, 7½ths.; depth from the top of the cask to the external surface of the head, 9in. 2½ths.,

making the total depth within, 37in.; the total content of both compartments is 3 barrels, the lower compartment 2¼ barrels, and the upper ¾ barrel.

For the purpose of fermentation, a quarter of a barrel in the upper compartment is sufficient for the filling-up during the whole process, and for a proper fermentation of ale at 32lbs. density, the space left in the upper compartment will be found sufficient to contain the whole of the yeast ejected. The diameter of the circular opening in the head is twelve inches.

Whatever may be the mode of fermentation in cask, in spring and summer, the tun should be pitched at so low a heat, and with so small a quantity of yeast, as to prevent a lower attenuation than to the standard fixed upon, or as near to it below as can be, without incurring the liability of an acetous fermentation, by too long an exposure to a heated and oxygenated atmosphere, before vinous fermentation commences. The pitching at such a heat, and with such a quantity of yeast as is sufficient to ensure the creaming of the tun at the end of 12 hours, will be found a safe system, and a proper time to adhere to; but with every precaution, it is more than probable that, in hot weather, the attenuation will be too low.

As in the spring and summer months, the brewer's foe is an oxygenated atmosphere at a high temperature, it is necessary that he should furnish his wort with more carbon than in the winter, to combine with the extra quantity of oxygen that his wort will absorb. This is to be effected by the impartation of more hops, or of better quality, and in greater quantity in the spring and summer, than in the autumn and winter.

I conceive it to be a great error in practice fallen into by many brewers, in pitching their tuns at too high a temperature, with too much yeast, and cleansing too late, trusting to mechanical methods for checking fer-

mentation, in case it goes on too rapid to suit their views, or if they are apprehensive that too low an attenuation may ensue. They first furnish too great a stimulus, and then endeavour to diminish or paralyse the effect produced. For such a purpose, I have known a refrigerator placed in a tun, in order to abstract the heat from the wort, generated by fermentation, to an amount proportioned to the views of the brewer: which appears to me to be a mechanical advantage, productive of a chemical evil; for as I have before shown that the impartation of yeast is for the purpose of aiding the process of decomposition, and the caloric converted from a state of latency to activity thereby, combines with the carbonic acid, and converts it into a gas; which effect is necessary, to enable its ejection from the wort, by reducing its specific gravity; and another purpose for which Nature has admirably contrived, first to store up such caloric, to hold it in subjection until needed, to accomplish her purposes, and then to impress it with the power of motion and combination, is, (in fermentation), to enable the carbonic acid, by its combination with it, to act mechanically in its ascent from the interior of the wort to the surface, by carrying up the floating particles of coagulated gluten, and causing their final ejection from the wort. Thus has Nature provided and endued this fund of heat, which man, not comprehending her operations, abstracts by mechanical means; and errs, in first imparting the agent to effect decomposition, and then abstracts the power to remove the excretory materials resulting from the formation of a new compound. Such is the evil which such, and other mechanical means which have been resorted to, create instead of diminish; for it must be obvious, that if yeast is added for the purpose of aiding and promoting the impartation of oxygen, in order to effect decomposition, and the addition and impartation being too great,

the decomposition must necessarily be so too; and as neither the agent or cause of decomposition can be abstracted, and consequently their work must be done, it must therefore be quite inconsistent to abstract the only power that will get rid of the excretory materials resulting from such decomposition and recomposition. As well might a builder pull down an old house, to build a new one with the available materials, and leave the rubbish resulting unremoved. Persons so acting appear to me to mistake the effect for the cause.

To furnish a summary then of all my recommendations on this head: pitch the tun at a temperature varying from 58 to 64 degrees, with yeast free from acidity, putridity, and in effective condition, and in the least possible quantity as will ensure its biting in 12 hours, and render the wort fit to cleanse in about 24 hours from the time of pitching, at an increase of temperature from 4 to 6 degrees, and, finally, fermentation to cease in the cask in 4 or 5 days from the day of brewing, and be quite ready to rack and send out on the sixth day. If such a system is pursued, good beer may reasonably be expected to be produced all the year through, but of superior quality in autumn and winter, than in spring and summer; and the cause of difference lies in the capability of attaining better to a right point of attenuation, or an approximation thereto, and because there is less liability of an improper absorption of oxygen previous to, during, or subsequent to, the foul fermentation.

Such being the case, in addition to all the precautions suggested to prevent too low an attenuation, and too great an absorption of oxygen during the spring and summer months, I must strongly recommend the practice of brewing little and often, and the sending out for consumption as early as possible after the fermentation

is completed, and the supply to each customer in quantity not exceeding a week's consumption, with whom it can conveniently be effected, and in such sized casks, as will be promptly drawn out.

After the fermentation is completed in the casks, or the trough beer is no longer wanted to fill up with, it should be drawn from the yeast and put into casks as promptly as possible, and any portion that may not be wanted for the purpose of filling up towards the termination of the fermentation, should be got into casks previous to its termination, or as soon as it is no longer wanted for filling up, in order that it may purge itself as much as possible, by fermentation and depuration. At the time the tun is pitched, all the trough beer from the preceeding brewing should be started into the tun, and if proper care has been taken between the brewings, that such trough beer has not been injured by negligence, or if not by unavoidable causes, then no injury will be done to the wort in the tun thereby.

In calculating the quantity of yeast required to pitch the tun with, the quantity of trough beer to be added is not to be taken into the account, inasmuch as such beer has been already attenuated by fermentation.

In adjusting the proper temperature at which to pitch the tun, the heat of the trough beer should be ascertained, with a view to the getting down the wort into the tun, at such a heat, as when mixed with the trough beer, the heat of the whole should be at the desired point.

Should a brewer have on hand a quantity of stale beer, more than is sufficient for the purpose of using for finings, for which he cannot find sale, or if he can, yet at a very great loss, the only period at which he can, with safety to himself, mix it with his new worts, is from the beginning of October until the end of March; and the best method of effecting it, is by breaking such

a quantity into the tun at the time of pitching, as is consistent with the state and temperature of the atmosphere, and the season of the year, and the quantity of acid the beer has acquired.

Between those periods, beer possessing a small quantity of acid, may thus be got rid of in small quantities, provided the guile is consumed promptly; but from the end of March to the beginning of October, it cannot be used in any way without doing mischief, and an attempt to effect it, will probably cause an increase, rather than a diminution of such an objectionable stock.

As wort, exposed to the atmosphere, will at any time of the year absorb a sufficiency of oxygen therefrom, for the purposes of fermentation, any addition beyond such a sufficiency, whether in the shape of stale beer, yeast, or any other material, is calculated to effect an acetous fermentation, in conjunction with the vinous, and to an extent proportionate to the quantity of acid thus introduced, and other contingent circumstances connected with the process of fermentation, subsequent management, and length of keeping.

In spring and summer, the great difficulty is to prevent too great an absorption of acid from the atmosphere, and every avoidable addition should be most carefully and sedulously prevented.

In spring and summer, wort invariable absorbs too much acid from the atmosphere, if kept sufficiently long before consumption, however favorable may have been the circumstances under which brewed and subsequently kept, and therefore quick consumption should be secured.

In autumn and winter, wort is not so liable to absorb too much acid from the atmosphere, and therefore an amount of acid may be imparted in the shape of stale beer, as may be equivalent to the amount of acid derivable in the spring and summer months from the

atmosphere, but as in both cases the extra absorption is injurious, so in both cases quick consumption is requisite to escape the consequences.

There are a variety of ways by which beer may be deprived apparently of its acid, but which are, in fact, but the neutralizing of the acid, by causing a combination of the acid contained in the beer, with carbon imparted in the substance of alkali, and thereby forming carbonic acid, but such methods are not sufficient to eradicate the evil, which soon exhibits itself again, and the carbonated base invariably imparts an ill flavor.

But there is a method by which a combination of carbon with the acid of beer may be effected, whereby carbonic acid gas is created, and in that state the acid is evolved from the beer, and effected without the impartation of any ill flavor; but as the use of every ingredient but malt, hops, yeast, water and isinglass, is prohibited by the Excise, in the brewery, it becomes not my province to impart that information, which might lead the informed into difficulties.

If beer was allowed to be deprived of its acid by the Excise, large quantities might be safely got rid of by such a method of deprivation, but it must be understood that any beer deprived of its acid, cannot be fit to send out alone, or that it can be by such means restored to its original flavor and strength, which constitutes the value attached to beer; for in proportion to the absorption of acid, so is the loss of flavor and quantity of spirit; and as the whole of the spirit contained in beer, is convertible into an acid, so such beer is never completely acetified until the whole of the spirit which it originally possessed, is thus converted, consequently an abstraction of that acid will not restore its spirit, nor yet the material which originally imparted a grateful flavor to that beer, or that is productive of spirit, but which has been expended in creating a new compound, an acetous acid.

Before mixing stale beer, which has or has not been deprived of its acid, with new wort, the quantity of spirit which it possesses should be ascertained, which may be effected by the distillation of a sample, and thereby ascertaining the quantity of proof spirit which it possesses per barrel.

In order to learn its comparative value, it is necessary to know what is the standard of comparison, as relates to the quantity of proof spirit, which good beer should possess; and to this point I have already called the attention of the reader, by stating that beer properly fermented, should yield one gallon of proof spirit for every five pounds density of attenuation to which such beer has been subjected. Thus, if a wort of 32lbs. density per barrel, has been attenuated to 12lbs. per barrel, one barrel of such wort should contain four gallons, or 100 gallons, 11gs. 1th. of proof spirit.

But the value of beer does not depend upon the quantity of spirit alone, which it possesses, but in addition to which the quantity of unattenuated fermentable material left in the beer must also be added; and, therefore, fairly to appreciate the value of stale beer, it is necessary also to take into the account, the point to which it has been attenuated, as well as the quantity of spirit it possesses.

If, for example, I wished to break into the tun one barrel of stale beer in every 20 barrels of wort, that is, 19 barrels of wort and one barrel of stale beer, and I had previously ascertained that such stale beer possessed 3 gallons of proof spirit per barrel, and was attenuated to 3lbs. per barrel, and I was desirous to get my wort into the tun as much above 32lbs. density as would be sufficient to make it at 32lbs. density when mixed with the stale beer, estimating the value of the stale beer in pounds density, in relation to the quantity of proof spirit it possessed, and the point to which it was at-

ated, what must be the mode of procedure to ascertain what should be the density per barrel of the 19 barrels of wort?

Rule.—If 4 gallons of proof spirit give an original density of 32lbs. what will 3 gallons give?

$$\begin{array}{ccc} 4 & 32 & 3 \\ & 3 & \\ \hline & 4)96 & \\ \hline \end{array}$$

Answer - 24lbs. density.

If a wort attenuated to 12lbs. density, was originally of 32lbs. density, of what original density may be considered a wort attenuated to 3lbs. density?

$$\begin{array}{ccc} 12 & 32 & 3 \\ & 3 & \\ \hline & 12)96 & \\ \hline \end{array}$$

Answer - 8lbs. density.

Then add together 24lbs. and 8lbs. and the amount will be 32lbs., which divide by 2, and the quotient will be 16lbs. which may be considered as the average value of the stale beer, in relation to the new wort, with which it is proposed to mix it.

Then multiply - 32lbs density
by - 20 barrels.

640

From which substract 16lbs the presumed density of the stale beer, and divide by 19)624(32lbs 8th. and the quotient will be the density at which the new wort should be adjusted to, in the tun, previous to breaking in the barrel of stale beer.

$$\begin{array}{r} 57 \\ \hline 54 \\ 38 \\ \hline 160 \\ 152 \\ \hline 8 \end{array}$$

Conceiving that the details and results of the fermentation of the guile of ale referred to in page 190, may impart useful information to some, I am induced to furnish them as annexed.

The density of the wort, when down in the tun, proved to be 32lbs. 2ths. per barrel, the quantity 50 barrels, and was pitched at 61 instead of 60 degrees as intended. The quantity of yeast used was 18lbs.

1835.			Heat of tun room.	Heat of tun.	Density of tun.
July	21	E 8	71 deg.	61 deg.	32lbs. 2ths.
	22	M6	66 deg.	62 deg.	slightly creamed.
	22	M11	68 deg.	63 deg.	rocky head.
	22	E 6	71 deg.	65 deg.	29lbs.6ths. cleansed.

			Heat of cleansing room.	Heat of butts.	Density of butts.
July	23	M7½	66 deg.	70 deg.	24lbs. 6ths.
	23	E 6	70 deg.	75 deg.	20lbs. 8ths.
	24	M6½	65 deg.	77 deg.	15lbs. 1th.
	24	E 6	70 deg.	79 deg.	11lbs. 6ths.
	25	M7	66 deg.	76 deg.	10lbs. 0ths.
	25	E 7	70 deg.	75 deg.	9lbs. 3ths.
	26	M7	67 deg.	73 deg.	9lbs. 0ths.
	27	M5½	65 deg.	71 deg.	8lbs. 7ths.
	27	E 7	69 deg.	70 deg.	8lbs. 7ths.
	27	E 7	Racked off a sample, and fined it down.		
	28	M7	Examined sample and found it nearly bright.		
	28	E 5	Examined same sample, and found it quite bright.		
	28	Began racking and sending out the guile in the morning.			

CHAP. XIII.

RACKING, FINING, AND SENDING OUT.

Here again, in this department of the brewer's business, no determined and invariable system can be furnished, that will ensure an invariably favorable result. General instructions can alone be given, and the judgment must direct the proper method of procedure, agreeable to the requiring circumstanees.

Beer should be in a fit and proper state to rack, to justify an expectancy that it will prove fit for consumption, if racked, fined down, and sent out on right principles.

We will first assume that it is so, and then direct the operation. Beer is in the best state for racking, as soon as the foul fermentation is completed, just at the time its fermentative powers are exhausted from the effects of its first efforts, and previous to the commencement of a new fermentation, induced by the absorption of oxygen from the atmosphere, which in warm weather will occur much sooner than in cold. If a second fermentation is induced by the absorption of oxygen, before the beer is become naturally or artficially fine, those floating fermentable principles in combination with the oxygen absorbed, will cause a second foul fermentation; whereas the brewer's object should be to cause a transparent fermentation only.

Now, in warm weather, it is next to impossible, if not quite so, to get beer to go naturally bright, (which pos-

sesses a sufficient quantity of fermentable matter in it, which has not been attenuated), before a second fermentation will come on ; and if it does come on before the beer is clean or freed from the foul inducing fermentative principles, which are floating in it, a foul fermentation must be the inevitable consequence. And this second foul fermentation is technically called fretting. It should therefore be the brewer's object, before such second fermentation commences, to have his beer racked from the lees, placed in the consumer's cellar, and fined down with isinglass. This primary principle should be attended to all the year round, but there are various modes of procedure to be attended to in carrying this principle into operation, in relation to the time of the year, the heat of the weather, the distance of conveyance, and other minor circumstances ; and the brewer should have a thorough knowledge of the various causes that induce a second fermentation, and the means to obviate, controul, retard or promote it, as circumstances and necessity may require. To assist the inexperienced, I will first point to several causes, and next to the several means which should be resorted to, to ensure a favorable result, which is, the consumption of beer during the time that it is subject to a second fermentation, but instead of its being a foul fermentation, it should be a perfectly transparent one. The causes :—1st. The remaining too long upon the lees, in the cleansing casks, and the absorption of oxygen from the atmosphere.—2nd. High temperature of the atmosphere in the cleansing room.—3rd. The state of the atmosphere, as relates to oxygen in a state of simple admixture with it.—4th. The impartation of oxygen by an admixture of old beer with the new, and in the state of finings, (isinglass being dissolved in stale beer).—5th. Removal from the brewer's cleansing room to the consumer's cellar, through a warm atmosphere, and agita-

tion by carriage.—6th. Casks into which racked, sometimes impregnated with a considerable quantity of acid.

On taking a theoretical view of the first causes, it appears to me that as the lees at the bottom of the cleansing cask, and the floating particles which cause the opacity of the beer, (the foul fermentation of which is just completed), are a compound of yeast, and an excretory substance resulting from the decomposition of the wort, which in the last feeble stage of fermentation could not be ejected from the bung-hole of the cask, and the latter of which are too light to subside to the bottom, that as soon as a fresh supply of oxygen has been derived from the atmosphere by the beer in the cask, the yeast contained in the lees, and that which is floating in the body of the beer, acts as a new medium to produce a second fermentation.

That such is the case, I think is proved by the analogous fact, that when yeast is taken up from the stillions and put by for use, it will, (sooner or later, as circumstances promote), get into what may be termed a spontaneous fermentation, but which in reality is occasioned by the absorption of oxygen from the atmosphere. This being the case, the sooner the beer is removed from the lees, the sooner it is removed from a considerable portion of the active agent which induces a second foul fermentation.

To this subject it is also due to state, that a second foul fermentation is sometimes occasioned by the first not being conducted on right principles, thereby leaving the beer too much loaded with the floating particles alluded to, and too much lees at the bottom of the cask, or to speak technically, the beer is not worked off clean. And this prejudicial effect is generally occasioned by a too languid or too powerful a fermentation; the first deficient in the requisite power to throw off the yeast created, which power has never been generated for

want of a sufficient stimulus; and in the second case, the stimulus being too great and of short continuance, the power is expended before the decomposition and cleansing of the wort is complete. To obviate such an effect from either of the above causes, it is necessary that good yeast should be used in pitching the tun, a right quantity and a right heat of the wort, so that a medium fermentation may result, and a vigorous power ensured, that may be sufficient to the purging of the beer from nearly the whole of its impurities.

The second cause:—The high temperature of the cleansing-room may originate from the heat of the weather, by being disadvantageously situated, and the atmosphere within, too much affected by the changes in temperature and state of the atmosphere without. Those who are about to construct new breweries, or alter old ones, should endeavour to ensure, as far as possible, a well ventilated cleansing room, and of medium temperature all the year round, as near at the point of 50 degrees as is possible. I am fully aware of the difficulties which may frequently lay in the way of the obtainment of such a desideratum, and the disadvantages which accrue to those who cannot command it. But I am equally aware, that an endeavour to obtain it, too seldom enters into the calculation of the projectors of new, or the improvers of old, breweries;—the object generally being to obtain certain mechanical advantages without any regard to the chemical consequences. I have mentioned a well ventilated room, because it is quite desirable that the heat and carbonic acid gas, which is evolved from the wort in a state of fermentation, into the atmosphere, contained in the cleansing room, should be expelled from such room as promptly as possible, otherwise the beer which is in a state of fermentation, experiences too great an excitement by the accumulation of heat, and is oppressed in its progress

of decomposition, not being able freely to throw off the carbonic acid gas, as fast as it is created. To obtain a cleansing-room of medium temperature all the year round, a vault, not immediately communicating with the external air, but obtaining its supply of air for ventilation, by a cool medium, such as contiguous vaults, under ground, drains, &c., is the best that can be chosen; but the difficulty lies in causing a sufficient quantity of cool air to pass through such a cleansing-room as is sufficient to carry off the heat and carbonic acid gas generated by the beer fermenting therein. To accomplish such a purpose, in many cases, mechanical means would be necessary; either a cool blast of air should be forced into the room, expelling the heated air and carbonic acid gas therefrom, through an aperture in or near the top of the room, or the heated air and carbonic acid gas should be withdrawn from it by an exhausting apparatus; (and that of Taylor's invention for exhausting mines of carburetted hydrogen gas, and ventilating hospitals, &c., seems to me to be well adapted for the purpose,) and whatever may be the motive power, which is used in a brewery for the purposes of grinding, &c., may be used for the purpose of working such an apparatus; but as in some breweries the fermentation of beer may be continual, and the quantity great, and consequently the quantity of heat and carbonic acid gas generated, proportionately great, it may be necessary that the withdrawing of both should be continual, and the exhaustion adjusted to rule; then in such case, I should recommend the use of Taylor's apparatus, and the motive power, water, giving motion to a very small overshot water wheel, the supply to which might be adjusted by a cock, and the quantity required, I think, would be very small.

Let us suppose that the cleansing-room is an arched vault, and in the centre of the crown of the arch, is an

aperture, closed by Taylor's apparatus, I should recommend that to such apparatus should be attached a metal pipe, nearly reaching to the floor of the cleansing-room, and open at the lower end, and a few small holes punched in the sides of the upper end, the purport of which would be to withdraw the carbonic acid gas through the aperture of the pipe at the lower end, (such gas occupying the lowest part of the room, being heavier than atmospheric air), and the heated air to be withdrawn through the small holes in the side of the upper end of the pipe, (such air occupying the upper part of the room, from its superior lightness to the carbonic acid gas) and the cold air entering into the room to supply the place of the gas and air withdrawn.

The third cause:—The state of the atmosphere as relates to oxygen in a state of simple admixture with it. I have before pointed out that pure atmospheric air is a compound of 28 parts of oxygen and 72 parts of nitrogen; and I have also pointed out that oxygen exists in atmospheric air in a state of simple mixture, and that in such a state it is more abundant in spring and summer than in autumn and winter, and also in what is termed "thundery weather," than in clear and serene, or other weather, and to this I have to add, that when wort is in a state of fermentation, or previous thereto, it absorbs oxygen from the atmosphere, (the absorption being the result of an affinity existing between the carbon contained in the wort and the oxygen contained in the atmosphere.) Now, if pure atmospheric air is alone in contact with the wort, the wort has to decompose that air,—it has to destroy the affinity existing between the oxygen and nitrogen, and appropriate to itself the oxygen, which is effected by the superior affinity existing between the carbon of the wort and the oxygen of the air. But here is a work to be done! affinity to operate against affinity; conse-

quently the operation of absorbing oxygen from pure atmospheric air is slow, and the quantity obtained is small. But when atmospheric air has much or little oxygen in a state of simple mixture with it, such extra oxygen not only forms an addition to the previous quantity present in pure atmospheric air, but, not being combined with any principle so as to form a constituent part of any other compound, it readily and without difficulty unites with the wort. It hence follows, that as Nature has wisely ordered that wort is capable, during fermentation, of absorbing as much oxygen from pure atmospheric air, by its decomposition, as is equal to its need, that the presence of any additional quantity, must prove injurious to it. I scarcely need add to these observations, that if the atmosphere of a cleansing-room is allowed to be impregnated with particles of acid, evolating from stale beer, or from slops, or in any way resulting from uncleanliness, that the beer in a state of fermentation, may be injuriously affected by its absorption.

Fourth cause:—The impartation of oxygen by an admixture of old beer with the new, and in the state of finings, &c. In the chapter on fermentation I have already pointed out the effect of mixing stale beer with new wort, in the tun, and need not repeat any observations: but something may be said relative to the mixing of store beer with new, at the time of racking, and the dissolving of isinglass in stale beer, for the making of finings. Store beer, in a fit state for use, should be perfectly bright, or that will fall bright, if fined down by isinglass, but if naturally bright the better.

Naturally bright store beer, attenuated to from 10 to 12lbs., without the acquisition of much acetous acid, and full of carbonic acid gas, is in the best state for use. A store beer, the original density of which was 32lbs. which was attenuated to 16lbs. in the first foul

fermentation, and was started into a vat situate in a suitable situation, in about a fortnight from the day of brewing, (the brewing and fermenting process having been well conducted, and all other circumstances rightly assisting), and which has been slowly and gradually attenuated therein, to from 10 to 12lbs. density, without having acquired much acid, must prove a valuable store beer, replete with spirit and carbonic acid gas, and in a desirable state to mix with new beer. Such beer will blend well with new, and the united beverage will prove a compound grateful to the consumer and creditable to the brewer. The proper proportions of new and old must be ascertained by experimental samples, which is a work of no difficulty. But some may ask, if attenuation to from 10 to 12lbs. is necessary, why not attenuate to that point in the first foul fermentation, and save all the tedium, loss, and expenses, &c., consequent on the keeping of a stock of store beer? If the production of spirit alone was necessary, doubtless such a method would be sufficient; but the creation of carbonic acid is also necessary, and there must be a sufficient quantity of fermentable matter left unfermented, or undecomposed, in the first foul fermentation, for the purpose of generating carbonic acid, during the second or transparent fermentation, and the spirit, and the carbonic acid created should be as much as possible preserved, the latter of which cannot be effected in a foul fermentation, because it is by heat converted into gas, and evolates during the process.

Nor would the peculiar flavor (technically called aged), possessed by store beer, which has thus slowly and imperceptibly been attenuated, in the course of many months, be acquired by a low fermentation effected in, probably, as many hours. And the impartation of this aged flavor to a certain extent to new beer, by the blending of the two in suitable proportions, is

an object sought in the use of store beer. The skill and judgment of the brewer, in mixing new and store beer in right proportions, agreeable to the state of each, and the requirements of his customers, the time of the year, &c., is highly necessary to the well conducting of his business. As relates to finings, it is too common a practice, for the sake of facility, in dissolving isinglass, to use the stalest beer which the brewery will furnish, for the purpose of (what is technically termed) cutting, and in case the brewery cannot furnish that which is deemed sufficiently stale, then that which is, is purchased; and this inconsistent and mischievous practice is pursued all through the year alike, without a thought bestowed on the chemical consequences produced on the beer to which it is applied, as finings. In winter, when beer through its various stages has escaped the evil of too great an absorption of oxygen, such a method may be pursued with impunity, and the mischief not developed before consumption, but still no other benefit than a mere prompt solution of the isinglass is obtained by it, and where consumption is not also prompt, the ill effects will be evinced. But in spring and summer, when the brewer's chief difficulty is to prevent too great an absorption of oxygen from the atmosphere, and when its heat, too, much promotes and accelerates fermentation, the unnecessary addition of stale beer, in which isinglass has been dissolved, must prove a very superfluous addition to the evil, and may appropriately be considered as adding "fuel to the fire." As a prevention to loss, if a brewer has unavoidably a quantity of stale beer by him, he may be excused in endeavouring to get rid of it (by perhaps this least objectionable method) during the winter months; but in spring and summer, if he wishes to diminish his stock of such an article, he must take especial care that he does not by such a method increase it instead.

In spring and summer, isinglass should be dissolved, and made up into finings of a proper consistence with good old store beer, or failing the possession of it, with stale and new beer mixed, taking time and frequent agitation, as a substitute for a more prompt solvent.

Being upon the subject of finings, the fittest opportunity presents to state, that the best isinglass, i. e. the pickings of the shop isinglass, or the best staple, is eventually much cheaper than that which may be bought at a less price.

To drink beer thick, or fined down with isinglass, the latter of the two evils is the least; and that isinglass, the least of which will effect the required object, is the best.

Finings should not only be made with good isinglass, and good beer, but should also be of about the consistence of cream, as in that state it will the better carry down all the floating particles (which gives to beer its opacity,) to the bottom of the cask, and will also keep them there.

In many breweries, not only is the improper use of stale beer adopted for finings, but the making them up too thin is also practised. The consequence of such a practice is, that too little isinglass, and too much stale beer, is administered: of the former not sufficient to carry down the floating particles; and of the latter enough to produce a second fermentation, or what is technically termed fretting; so that that which was not done at the right period, cannot be afterwards done; for while beer is in a second state of fermentation, or fretting, it cannot become bright, and when once put into that state it seldom ceases, on the right side of a vinous fermentation, but goes on to an acetous, and is too frequently accelerated to such a stage by the inconsistent addition of more finings, which prove but an increase to the evil.

The most proper period for the action of isinglass, on beer, is when its first fermentative powers are exhausted, and no opposition within the body of the beer is presented to the union of the floating particles with the isinglass, and the descent of the whole to the bottom of the cask, and enough isinglass should be inserted at once as is sufficient to combine with, and carry down, every impurity: and I should recommend those who are not well acquainted with the operation of isinglass, to take a decanter and fill it with new beer from the cleansing cask, as soon as it is worked off clean, and put finings to it, and they will witness a beautiful and instructive operation.

I should also recommend the same, to fill another decanter with beer in a visible state of second fermentation, and they will find that carbonic acid gas, which is formed at the bottom of the decanter, is unceasingly rising to the surface, agitating the whole body of the liquid and carrying upward every floating particle that obstructs its course: and they will soon be convinced that the addition of isinglass to beer, in such a state, is quite useless.

The fifth cause:—Removal from the brewer's cleansing room to the consumer's cellar, through a warm atmosphere and agitation by carriage.

That artificial heat promotes fermentation, I trust that the most uninformed brewer is fully aware, and to illustrate this subject, let us suppose that the temperature of a brewer's cleansing-room, on a hot summer's day, is at 60deg., and the atmosphere, without doors, in the shade, is at 80deg., and in the sun at 100deg., (cases of common occurrence). That beer is racked at a proper period, and in a proper state and manner to send to a consumer, at least a day's journey distant. The temperature of this beer, when racked, is at 60deg. The new beer contains a large quantity of carbon, and the

old store beer mixed with it, a sufficiency of oxygen to induce a second fermentation, by the power of affinity alone, without the excitative influence of increased temperature and agitation. This beer is racked foul from the cleansing cask, and not only possesses the inherent principles to cause a second fermentation, but also possesses the adventitious that are floating in it, which were never ejected from the cask during fermentation, or subsided to the bottom subsequent to it. Can it then be other than expected, that a fluid purposely left fermentable, and with a fermentative power purposely added, should necessarily obey the exciting influence of increased temperature and agitation.

The removal of beer, then, under such circumstances, must be considered an evil, and, if possible and convenient, should be avoided.

If possible to get it quite bright before it is racked, without the addition of any acid, it appears to me that such is the preferable method; but if not, then it should be sent under the most favourable circumstances that it can be. It should not be racked until just before it is sent off; it should be conveyed in the night, and if necessarily during part or the whole of the day, should be protected from the sun, by some means. The casks should be well filled to the bung, to prevent agitation more than is unavoidable. The finings should not be put in previous to conveyance, but taken to the consumer in a separate cask, for his management at a proper period. The moment it is placed in the consumer's cellar, every bung should be drawn, to let out the carbonic acid gas which has been generated during the conveyance; and they should be left out, with instructions to the consumer, to fire down each cask about twelve hours before he wishes to tap, and not to bung down again, unless there is no appearance of a disposition to fret.

The sixth cause:—Casks into which beer is racked, are sometimes impregnated with a considerable quantity of acid; and to this might also have been appended, that cleansing casks frequently become so, between the time of emptying and refilling, a circumstance frequently unavoidable, when the greatest care is taken; and when left unstopped after being emptied, and exposed to the access of air, previous to being scalded, it is natural to expect they will become so in hot weather. As relates to casks in which beer is sent out, the careless state in which the consumer leaves them when emptied, and the improper situation in which he too generally places them, it is but natural to expect that they will become impregnated with acid to a considerable degree. But of this fact, I believe, that few brewers are aware; an attention to the minutiæ of their business is left to servants, who never like to find themselves work; and what the master does not discover, the servants will not acquaint him with, if it militates against their convenience. But it is an important fact, and much beer is spoiled in consequence, and it should be known, attended to, and remedied. As a remedy, some brewers use lime, putting into each cask a small quantity, with a very small portion of water, and bunging the cask down, the lime is left to slake all night, and in the morning hot water is put into it, and the cask is twice or thrice scalded out.

But this remedy does not appear to me to be so effectual as the scalding out each cask with boiling hot lees, made with lime and wood ashes, as will be explained in the 18th Chapter, returning the lees to the lime and ashes after use, in order to its being freed from the acid which it has extracted from the cask, in its passage through the lime and ashes. After such scalding, two or three scaldings with clean hot water is requisite to withdraw the lees froom the wood.

In the supply of beer to customers, the brewer's maxim should be "little and often in spring and summer, and much and seldom in autumn and winter;" for in the former case there is always the danger that beer will reach the state of an acetous fermentation, and the brewer's object should be to ensure consumption before it occurs. And in the latter case, beer should not be consumed until the new and old are well amalgamated by a transparent fermentation, and to effect which a considerable time is requisite in very cold weather, and it may be necessary that it should be placed several days in the consumer's cellar before it is fit to tap.

The consequences of an over supply in the first case, will, probably, be foulness and acidity; and, in the latter case, flatness and double flavor.

CHAP. XIV.

STORE BEER,

In a state of perfection, should be perfectly sound, fine flavored, full in the mouth, brilliantly bright, mild, spirituous, and replete with carbonic acid.

To the experienced brewer, these technical terms are, doubtless, quite familiar, but to the young beginner some explanatory observations may be acceptable. "Sound" implies a freedom from a predominant quantity of acid, uncombined with carbon. In such a state of combination, the compound is termed carbonic acid, and in this compound state, beer, which may be replete with it, will not taste acid. But still such beer cannot literally be said to be free from acid.

"Full in the mouth." Beer, which may be said to possess this desirable and characteristic quality, must be full of carbonic acid, and yet retain a large quantity of the extract of malt, which has not been decomposed by the process of fermentation, and which gives to it a full and sweet taste. Opposed to this term, is "thin on the palate," which term applies to, and is descriptive of, beer which has been attenuated low, and possessing but a small quantity of the extract of malt, which has not been decomposed by fermentation: it drinks thin, or light to the taste.

Having described what good store beer should be, the next point of consideration is—What should be the process to endeavour to obtain all the good qualities described, and what are the essential requisites to ensure it?

The necessary ingredients (and none other) are good malt, hops, water and yeast. Brewers should be particularly careful in selecting the best malt they can possibly procure for the brewing of store beer, for as the requisite qualities to constitute good store beer are several, so the malt, from which their basis is derived, should possess and impart the right principles, and in right proportions, otherwise right results cannot reasonably be expected. I need not here describe the several properties of good malt, because I have already endeavoured to point them out, but I will state that it is my opinion, that three-fourths home-dried pale, and one-fourth amber malt, is better for the purpose than all pale; particularly when the brewer cannot command an eligible situation for his vats. My motive for recommending the use of one-fourth of amber malt, is because it possesses less fermentable matter than pale malt, and by practice and experience I find it best calculated to secure to store, or running guile beer, the desirable qualities already named.

Good strong new hops, and plenty of them, should be administered, and the purport of using such is to prevent store beer from getting stale, during the time that it is kept, previous to consumption; but not that it may taste unpleasantly bitter, at the time it is consumed. Hops are used more for the purpose of keeping beer sound, during the process of both the foul and transparent fermentation, than for the impartation of their flavor, not but that the fragrant bitterness they impart to beer is grateful to the habituated taste; but the generality of consumers require but the presence of a small quantity of it, at the time of consumption; but the impartation of a large quantity, previous to fermentation, is necessary to the retention of a small quantity, subsequent to it, because, during the process, it is continually diminishing.

The following details of a general process for the brewing of store-beer, may be serviceable:—From good malt, appropriate the first and second worts, and in a state of admixture to the required strength, for the guile of store beer, appropriating the remainder of the extract for table beer, or a return wort for the next brewing.—Boil the first wort one hour and a half, and the second three hours.—Boil nearly the whole of the hops intended for the two worts in the first wort, returning the spent hops to the second wort, and add the remainder of the dry.—Pitch cool, with a moderate quantity of yeast, and break trough beer of former store guile into tun.—Cleanse early, and rouse well at the time of cleansing.—Fill up with trough beer as often as needed, until the foul fermentation is completed.—Let stand in cleansing butts about a fortnight from the day of brewing.—Start into vats of suitable size to consumption.—Let the vats be situate in a room well ventilated, the temperature of which never exceeds 60deg. and is never below 50deg.—Provide an aperture at the top of the vat, for the escape of carbonic acid gas, as fast as it is generated, without the means of ingress to atmospheric air.

The motives for thus proceeding are: that as worts possessing much gluten, is more liable to an acetous fermentation than that which possesses but little, it is desirable not to mix any of the third wort with the first and second, because the latter extracts from malt contain more than the first. And, again, as the first extracts contain more saccharum and fecula than the last, and as saccharum produces spirit, and as fecula is convertible into saccharum by fermentation, so it is necessary to obtain for the guile of store beer, as much saccharum as the malt will yield, as well the fecula, for the purposes of conversion, in order that the store beer may be replete with spirit, when it has passed

through the several stages of sensible and insensible fermentation. And the purport of producing spirit, is to inebriate and to preserve the beer sound,

The appropriation of the residue of the extract obtainable, after the first and second worts to the production of table beer, with or without fresh malt, is doubtless better than carrying over a return for another brewing of ale, but when table beer is not wanting, it becomes indispensably necessary to carry over a return wort for the first mash of the succeeding brewing.

The motive for boiling both worts so long are two-fold, the coagulation of a considerable portion of the gluten which has been extracted from the malt, and the extraction of the whole, or as much as possible, within that period, of the bitter principle contained in the hops. The purport of coagulating the gluten, is to abstract it from the wort, for being unavoidably extracted from the malt, and being in a state of intimate and chemical combination with the saccharum and fecula in the wort, boiling is the only expedient in the hands of the brewer to separate a portion of it from the wort, which is done in a coagulated state, and may be observed in the state of flakes, if boiling wort is poured into a glass. The object of such separation is to abstract it, with a view to the prevention of the store-beer becoming stale, it being found, by practical experience, that store-beer, possessing much gluten in its composition, will not keep sound so long as beer which has but little. But it must be borne in mind, that an impartation of gluten to, or an abstraction of it from, a wort may be too great, for where there is no gluten, there can be no fermentation, and where there is too little, there may be an incomplete one; and where there is too much, there is the probability of there

being a fermentation extending beyond the vinous into the acetous. As preservation from an acetous fermentation, is of more importance than delicacy of flavor to store beer, economy prompts the double and long boiling of the hops, with a view to the extraction of as much bitter principle as is not of noxious flavor, and as is requisite for the purpose, from the smallest quantity of hops.

If store beer is to be kept a year, or any other period, enough of this bitter principle should be imparted, to combine with the oxygen which such beer will absorb within the year, or other period, and also during its consumption. But the quantity of oxygen that may be absorbed cannot be previously ascertained; and the absorption may be exceedingly variable, and consequently no satisfactory data can be afforded, to enable the calculation of a proper quantity. It will therefore be advisable to err on the right side, by putting too many hops rather than too few.—The purport of boiling nearly the whole of the hops in the first wort, and returning them into the second, is that by boiling them four hours and a half, the object before named may be accomplished. And the reason why the whole quantity required for both worts, is not put into the first wort, is because it cannot be ascertained until the second wort is down in the under back.—By pitching a tun cool, the advantages resulting may (for the sake of clear illustration) be compared to a person who commences a journey cool and collected, and travels at a steady and moderate pace, and terminates it with a sufficient stock of vigour left, to travel another stage the following day.

By pitching a tun high, the disadvantages resulting may be compared to a person who starts hot, and in a state of excitation, and continues, at rapid strides, to pace away his strength, terminating the journey in a

state of exhaustion, and is thereby rendered unfit for the labours of the next day. From the time that a tun is pitched, until the close of the first fermentation, the wort will increase in temperature to a maximum point, and from that point decrease, until finally it arrives at the temperature of the atmosphere by which it is surrounded. But the maximum point is not definite and invariable, but dependant on a variety of circumstances, such as the quantity and state of the yeast used, the heat of the weather, the time of the year, the quality of the malt, &c. The cause of the rise in temperature of the wort during fermentation is, that by the decomposition of the wort, latent heat is converted into free or active heat, in the ratio of the decomposition effected. If one tun was pitched at 60deg., and another at 70deg., and both with a wort divided into equal quantities, pitched with the same yeast in equal quantities, and every other circumstance attending, exactly similar, it must necessarily occur, that the maximum heat to which the tun pitched at 70deg. would attain to, would be much higher (and probably 10deg. higher) than the one pitched at 60deg., provided that the decomposition of each was to the same extent; but as in all probability the decomposition of the former would be much greater than the latter, consequently the greater would be the quantity of latent heat converted into active, and therefore the maximum attainment also higher. By reference to my journal, I find a brewing on the 12th Dec. 1833, affords the following particulars:

65¾ bls. of ale, at 33lbs. 5ths., pitched Dec. 12th, E 8, at 60degs., with 62lbs. yeast, temperature of tun room 46degs.

Dec. 13th, E 5, heat tun room, 44deg.; heat tun, 61 deg.; density tun, 30lbs. 6ths.,; at such time it was cleansed into butts.

			Heat Cleansing room.	Heat of butts.	Dens. of butts.
Dec.	14	M 8	47deg.	59deg.	26lbs. 5ths.
	15	M 7¾	50deg.	60deg.	21lbs. 5ths.
	16	M 6	52deg.	60deg.	17lbs. 9ths.
	19	M 8	53deg.	55deg.	14lbs. 3ths.

Another brewing, on the 10th February, 1835:—49¾ barrels of ale, at 31lbs. 5ths, pitched February 10th, E 7, at 65deg., with 40lbs. yeast, temperature of tun room, 45deg.

February 12th, M 9, heat of tun room, 47deg.; heat of tun, 65deg.; density of tun, 26lbs. 3ths.; at such time it was cleansed into butts.

			Heat Cleansing room.	Heat of Butts.	Dens. of butts.
Feb.	13	M 7¼	46deg.	63½deg.	18lbs. 5ths.
	14	M 8	48deg.	59 deg.	15lbs. 7ths.
	15	M 8	49deg.	55 deg.	15lbs. 3ths.
	16	M 7½	50deg.	52 deg.	15lbs. 3ths.

July 13th, 1835. I examined such beer in the vat, and found it in excellent condition; heat of vat room, 62deg.; heat of beer, 59deg.; density of beer, 12lbs. 5ths.

These two brewings, among many others which I could furnish, satisfactorily prove, that an attenuation to a right point, or thereabout, may be obtained by pitching at a low heat in cold weather, with a large proportion of yeast, or with a smaller proportion, at a higher heat.

The following will shew the results of a fermentation in hot weather.

27 bls. ale, at 32lbs., pitched July 15th, 1834, E 9¼, at 61deg., with 24lbs. of yeast, temperature of tun room 67deg.

July 16, E 9, heat tun room, 66 deg.,; heat tun, 65 deg.; density 25lbs. 8ths.; at such time it was cleansed into butts.

		Heat Cleansing room.	Heat of butts	Dens. of butts.
July 17	M 7¾	64½deg.	70½deg.	22lbs. 2ths.
17	E 6¼	70 deg.	77 deg.	16lbs. 1ths.
18	M 8	70 deg.	81 deg.	9lbs. 2ths.
18	E 7	68½deg.	79½deg.	7lbs. 7ths.
19	M 8	64 deg.	76 deg.	7lbs. 4ths.
20	M 8	63 deg.	71 deg.	7lbs. 1ths.
21	M 7	62½deg.	68 deg.	6lbs. 8ths.

By an examination of the particulars of these three brewings, it will appear that the first was pitched at 60deg., and the last at 61deg., the proportion of yeast to each the same. The obvious conclusion to be drawn from the circumstance of the maximum heat being so much higher during the fermentation of the latter than the former, and the attenuation so much lower is, that the quantity of oxygen in simple mixture with the atmosphere being so much less, and the temperature of the atmosphere in the cleansing-room being so much lower than the heat of the wort in the butts, during the fermentation, as per the first example, the latent heat converted into active, by the decomposition of the wort, was rapidly abstracted from it by the atmosphere; and by thus losing the heat as fast as it was converted from a latent to an active state, the stimulating cause of the impartation of oxygen (heat), and consequent decomposition of the wort being abstracted, the point of attenuation attained to, fell far short of the last example. And from the last example we may learn, that in consequence of the high temperature of the tun and cleansing-rooms, and the large quantity of oxygen mixed with the atmosphere, that the wort pitched at six degrees below the heat of the atmosphere in the tun-room, was stimulated to rise in heat by a treble cause, the superior heat of the air, the heat rendered active by decomposition, and the consequent impartation of much oxygen; and although the effect of the latter cause soon placed the wort in heat beyond the air, yet the difference between each being less in

the latter example than in the former, the abstraction in the latter case would not be equal to that in the former, and consequently fermentation was urged on to a greater extent. The latter example of fermentation I have selected, principally because the same proportion of yeast happened to be used, as in the former case. But such ought not to have been; and the very low attenuation may be chiefly attributed to it. The quantity of yeast used should have been 10¾lbs. instead of 24lbs., and the latter was used in error. In the first and third examples, four and a half tenths of an ounce of yeast to one pound density of wort was used, but in the latter but two-tenths should have been used.

By breaking the trough beer of the preceding brewing of store beer into the tun at the time of pitching (and nothing else should be broke into store beer), you best get rid of it, and without injury. And such time is preferable to any subsequent period, because no check is given to the fermentation, which would be the case, if subsequently introduced at a lower temperature, as well by a disarrangement of the process of decomposition, by the addition of another compound, possessing distinct properties.

"Cleanse early, and rouse well at the time of cleansing." Under the last head I have recommended to pitch cool, and with moderate quantity of yeast; and I now recommend to cleanse early, to prevent in winter the ill effects of a transition from the tun, at a high temperature, into cold butts, situate in a cold room; and as the wort in tun cleansed early cannot have acquired much vigour, I recommend rousing, to excite more, the better to enable it to bear the transition without injuriously experiencing the ill effects of the check which must necessarily be given.—The process of fermentation in the cleansing casks is a threefold operation,—a decomposition, and recomposition,

and the rejection of the excretory principles resulting. If the latter is not facilitated, the two former cannot go on as they should; and to promote the latter, the filling up the casks with trough beer is necessary. But to form a correct judgment how often the trough beer should be returned into the casks from whence it has issued, it is necessary to take several circumstances into consideration. Accompanied with the yeast ejected from the cask, is a large quantity of wort, and the object of the brewer should be to return that wort into the cask, more or less freed from the yeast mixed with it, as circumstances may prescribe as unavoidable or necessary. To return yeast into a cask, which must be again ejected, is worse than useless, because it is giving to the wort the double labour of twice rejecting, or oftener, that which would prove injurious to remain: and as the power of the wort to reject, is continually diminishing, if the return should be continual, it would at last become impossible for it to reject it; and the consequence would be, that the wort would be loaded with a large quantity of floating yeast diffused throughout its body, at the end of the foul fermentation, instead of being worked off clean; and which would induce a second foul fermentation (termed fretting), instead of the beer being subject to a transparent second fermentation, after being racked and sent out.

To obviate the objection, it might at first view appear desirable, either not to return the beer which is rejected from the cask during fermentation, in order to avoid returning the yeast mixed with it, and to fill up the cask with clean unfermented wort, or clean fermented beer, or refrain from the filling up until the yeast was well separated from the trough beer. But there are strong objections to either method. Nature has wisely ordered that one of the conditions of a good vinous fermentation is, the slow, gradual, and natural

increase in temperature of the wort to a maximum point, and from that point a similar decrease to a minimum point (the heat of the atmosphere). To ensure both, the necessary conditions should be fulfilled that Nature requires, without any acceleration or retardation of this increase and decrease of heat. And as the process of ejection of the yeast from the cask requires that it should be kept occasionally full, and never allowed to be far short of being full; and as that with which it is filled should be nearly of the same temperature as the wort in the cask, lest the bulk should be injuriously decreased in heat, it is necessary to fill up the cask at such periods of time as will allow a portion of the yeast to separate from the wort in the trough, without the latter becoming too cold before it is returned into the cask. But no definite time can be prescribed at which such fillings up should take place, because it is one of those many operations in the brewing process at large that must be controlled by the judgment of the superintendant, as circumstances dictate or suggest. The heat of the cleansing-room, the heat of the wort in the casks, the rapidity of the fermentation, and the period of its progress, are a few circumstances, among others, that must govern the experienced superintendant. But it may be urged, why should not unfermented or fermented wort be kept of the same temperature as the wort in a state of fermentation, for the purpose of filling up the cask, and to prevent the necessity of returning any portion of ejected yeast? The reply to such a suggestion is, that the state of decomposition in which the wort, in a state of fermentation in the cask, must be, would not be the same as the unfermented or fermented wort introduced, and consequently the introduction of it would create disorder in the process of fermentation going on, by a derangement of the chemical affinities

in operation. And the artificial means to keep such a material of the right temperature would be inconvenient, and in one case, cause a spontaneous fermentation, and in the other, a loss of spirit, before either were used. Thus far my observations apply to the filling up the casks by manual labour, but I much prefer, both in a chemical and mechanical point of view, the self-acting system of filling up, which I have already described in the Chapter on Fermentation.

Store beer should go into the vat as clear as possible from the cleansing casks, and therefore it is advisable to let it remain in the latter a sufficient time for the floating impurities to subside to the bottom of the casks before started, but not so long as to allow a second fermentation to come on in the cleansing butts, otherwise the evil would be increased, instead of diminished. In cold weather a fortnight will be found about a sufficient time for the purpose.

Vats, of suitable size to consumption, is a point that should be attended to, because store beer in draught will deteriorate in quality, and the longer it is in draught the worse it will get; and I am of opinion, that the size most suitable for a brewer, is such as, according to his usual consumption, will continue in draught not more than a month; but if necessarily it is longer, then it may be advantageous, when a vat is one-half, or three-fourths out, to rack it off into hogsheads or barrels, leaving it therein until recovered from its flatness, and begin upon another vat, mixing a portion of that which has been so racked into every cask going out, with a much greater proportion of the new vat. As soon as all the store beer is drawn from a vat, the grounds should be left in, and the vat secured from the access of air until the time of re-filling, previous to which, in some cases, well scalding will be sufficient; but often it is necessary to wash a vat well with boiling

transparent fermentation. Also that the decomposition of the store beer, in such state of fermentation, converts latent into active heat, and that such heat combining with the carbonic acid, converts it into carbonic acid gas. And such an operation is necessary, to cause the evolation of the carbonic acid; but it should be the brewer's business to allow the escape of so much as suits his purpose, and no more. But once converted into gas, and the retention of it in a vat, in any considerable quantity, would be impossible, even if desirable, without the great risk of bursting it. But it is to the brewer's interest that he should retain a considerable portion of carbonic acid; and to effect it, he must take care that the decomposition of his beer, and its consequent increase in heat, is not too rapid, else the carbonic acid created must necessarily be lost as fast as it is produced; and he should also allow the heat that carbonic acid gas generated, freely to escape as fast as it is produced, for if he attempts to confine both within the vat, by carefully closing every aperture, he will cause the creation of carbonic acid gas, by the accumulation of heat, so rapidly, that it will soon become too powerful for every opposing barrier, and make its escape to a much greater extent than if no opposition to its egress had been presented, and will cause a turbulent and foul fermentation to the beer within. But at the same time, while it is necessary that the carbonic acid gas and heat should be allowed freely to escape continually, and as fast as it is generated, the ingress of atmospheric air should be prevented. For this purpose an open tub should be placed on the top of the vat, with water in it. A pipe should be inserted into the head of the vat, and rising sufficiently high, should be bent over the side of the tub, and downward into the water, a few inches, say four or six inches. The vat should be quite filled, and the man-hole, and

every aperture, closed hermetically tight, and a quantity of sand laid over the whole head, to the depth of about six inches. By this arrangement, the carbonic acid gas and heat, as fast as generated will pass through the pipe into the water, and rising to the surface, will from thence make its escape, but the atmospheric air cannot find access by the same medium. Care should be taken that the pipe does not dip too deep into the water, because, in proportion to the height of the water above the orifice of the pipe, is the pressure presented to the gas which must pass that orifice, and consequently the greater will be the difficulty with which it will make its escape.

Many brewers are in the habit of putting spent hops in their vats, but it is a practice which I by no means approve of, finding by experience that more harm than good results from it, as relates to the quality of the beer, often causing a foul fermentation, and imparting a nauseous flavor, and causes a considerable waste by an absorbtion of store beer, which it is difficult to separate therefrom, even by pressing, being mixed up with the beer grounds, and if extracted is but of little value.

CHAP. XV.

PORTER.

The first and one of the most important points of attention in the brewing of porter, is the judicious and necessary blending of malt, dried of different shades in color, or the selection of malt, dried to an exactly correct shade.

But as the obtainment of the latter is much more difficult than a correct admixture of malt differing in color, the latter mode is generally practised. But color is not so much the desideratum to be sought, as flavor. If it was, a more economical substitute for brown malt might be used, yielding the brewer more profit. And, if I am correctly informed, there are brewers who draw their lengths for porter from pale malt, instead of pale and brown, or pale, amber and brown mixed, because the former yields more extract per quarter, than the admixture will do, and such persons are said to impart the necessary color by a suitable portion of patent malt, —as it is termed—which is a malt roasted to a state of blackness. And as relates to the flavor of such a production, the consumer might drink with almost as much zest, a decoction of raw and burnt coffee, instead of an extract from such as is equably and moderately roasted.

To obtain a right flavor, as well as color, I prefer an admixture of pale, amber and brown, to that of pale and brown only ; and, as relates to right proportions of each, it is impossible to furnish any correct rule, as two kilns of malt are seldom dried exactly alike ; and, as in

some towns and counties, it may be requisite to furnish to consumers porter differing very materially in color and flavor, from that which would be most approved of in others. In this respect, a brewer should first discover what his customers best like, and then, by repeated modifications and trials, endeavour to produce such as is approved of, nor cease until he has accomplished it. Again: if correct instructions could be given, the ale and porter brewer would need additional information to such as would be required by the brewer of porter only.

But, as I cannot give positive instructions as to right proportions of malt to either one or the other, I must content myself with furnishing such suggestions as occur to me, which may probably prove serviceable to those who are entirely unacquainted with the subject.

To the uninformed brewer, who is desirous of brewing porter only, I should recommend him to make his first experiment on half pale and half brown, or one-third of each, pale, amber and brown, such as is to be obtained by purchase, or such as his own, or his maltster's judgment may cause to be made, and if his worts do not come down to the eye sufficiently high in color, or to the taste in flavor, let him add to the wort in the copper, as much ground roasted malt, as he thinks may be necessary. If he finds that his color and flavor is too high, he can add a suitable portion of ale in racking, as may be sufficient to correct it. If he hits it right in his first brewing, he can continue his course until an alteration in his malt, or other circumstances, require a deviation, and then his judgment must be exercised to set him right again. If he hits it wrong the first brewing, then he must carefully note all the apparent causes, and make such alterations in his second brewing as his judgment may dictate. To the brewer of ale and porter, both the same suggestions apply. But as it may frequently occur to him (as it does to myself) that he

may be required to carry over a return wort from a brewing of ale to a brewing of porter, he must adjust the proportions of his several sorts of malt, according to the quantity and strength of the return wort carried over. And in such case, the proportions of each will differ widely from what they should be, when he has to mash with water.

In the case of carrying over a return wort, my method is as follows:—Suppose, for the sake of illustration, I intend to brew 20qrs. of malt for porter, and have to carry over a return wort of 40bls. at 8lbs. density. But in case I had not carried over a return wort, I should have mixed 10qrs. of pale, and 10qrs. of brown malt, or 7qrs. of pale, 7qrs. of amber, and 6qrs. of brown malt, it is, therefore, required to know, what should be the respective proportions for mashing with the return wort. To make the proper calculations, it is first necessary to state the produce of the pale malt to be used, at what it has been found, upon an average, to produce, or what it is imagined it may produce in extract per quarter in raw wort, and then multiply the 40bls. of return wort, by 8lbs. density, and divide the amount by the number of pounds density, as the extract of a quarter of pale malt; and the purport of so doing is to ascertain how many quarters of malt, the extract contained in such return wort is equal to.

For example: let us suppose the extract per quarter to be 90lbs. then multiply 40bls:

by - 8lbs.

and divide by 90lbs.)320(3qrs. 4bus. 4ths. to which the extract in the return wort is equal.

```
                     by   -   8lbs.
and divide by   90lbs.)320(3qrs. 4bus. 4ths.
                       270
                       ---
                        50
                         8
                       ---
                    90)400(4
                       360
                       ---
                    90)400(4
```

I should then make up the grist as follows:—Either 6½qrs. pale, and 13½qrs. brown malt, or 3½qrs. pale, 7 qrs. amber, and 9½qrs. brown. But it must be remembered, that in using such a proportion of brown as 13½qrs. to 6½qrs. of pale, the malt should be either crushed between rollers, or ground very coarse (the former preferable), as in case it should be ground fine, there would be much risk in setting the goods.

In taking the heat of the first mashing liquor, for porter, it may, both with safety and advantage, be taken higher, if the malt is crushed between rollers, than if ground between stones; and higher if ground coarse, than can be if ground fine. I have, for more than the last four years, been in the habit of brewing porter from malt crushed between rollers; and, on reference to my journal within that period, I find that the heat at which I have taken for the first mash, has been from 166deg. to 178deg. In taking the first mashing heat for porter, I am governed by the heat of the malt, and make the same calculation as for ale, and refer to the same tables. But should the average weight of the malt, when mixed, be below 36lbs. (the lowest weight at which I have furnished a table), it will be necessary for the brewer to make a calculation purposely for such brewing.

The high heat of 178deg. for the first mashing heat of porter, which I have stated as having taken, is so much higher than the heat prescribed as proper by any work on brewing which I have ever read, that I expect the reader may feel surprised at the assertion, and be inclined to doubt its truth, and the more so, when I now state, that I have mashed at that heat the first mash; when the relative proportions of malt have been 9qrs. of brown, and 5qrs. of pale, and the mashing menstruum has been 30bls. of return wort, at 9lbs. density.

To prove that such is not improbable, I think the following calculation will be sufficient.

	lbs.		lbs.
Weight of brown malt per bus.	30	and pale malt	40
Bushels per quarter - - - -	8		8
Weight of one quarter of malt	240		320
Quarters of malt brewed - -	9		5
Weight of 9qrs. of brown malt	2'60	& 52qrs. pale	160
do. of 5qrs. of pale do.	1600		
do. of 14qrs. mixed - -	3760		
Heat of malt - - - - - -	40		
	150400		

Weight 1bl. wort, at 9lbs. density per bl.	371lbs.
Quantity of return wort mashed with -	30 barrels.
Weight of 30bls. of return wort - - -	11130lbs.
do. of 14qrs. of brown and pale malt	3760lbs.
do. of return wort and malt - - -	14890lbs.
Mean heat required for goods when mashed	144deg.
	59560
	59560
	14890
Total heat & wt. of goods when mashed	2144160lbs.
Deduct heat and weight of malt - -	150400
Divide by weight of return wort	11130)1993760(177¼ degrees, the mashing heat required.
	11300
	86376
	77910
	84660
	77910
	6750
	4
	11130)27000(2

Should the heat of the grist be 80deg. instead of 40 (which difference will occur in a year), it would be ne-

cessary to mash the same proportions of malt, with a return wort of the same quantity and density, at 165½deg. instead of 177½, as may be evidenced by a similar calculation. And as 80deg. is as high as malt is likely to be, resulting from the heat of the atmosphere, and from crushing or grinding, it is not probable that so low a heat as 160deg. need be taken for the first mashing heat, unless upon any extraordinary occasion, such as brewing malt warm from the kiln, or mashing with a larger proportion of menstruum.

The demonstrative proof thus furnished, that a difference of as much as 12deg. of heat in the mashing menstruum (all other circumstances being alike, except the heat of the malt), may be necessary to produce the same result (a grist of 144deg. after mashing), is, I think, sufficient to convince the reader of the importance and value of the system submitted, by which he may be able satisfactorily to ascertain, at all times, the mashing heat he should adopt, to obtain, as near as possible, an invariable result, and that the invariable heat of 160deg., prescribed by several authors, is no more to be depended upon, than an expectation that malt may be found at the same temperature throughout the year, and under every varying circumstance.

The second mash, which I always make for porter as well as ale, is what is termed, a fly mash; which, in the seventh chapter, I have explained the mode of effecting. And to 20qrs. of malt, I turn over, at boiling heat, 15bls. of liquor from the copper, which is allowed to stand on the goods twenty minutes before the taps are set. And when the wort is down, the process of sparging with water, at about 160deg., commences, which is carried on in the manner as before described for ale and table beer; and the goods are thus washed, until the wort which runs off weighs from 1½ to 2lbs., and the worts for boiling are regulated as circum-

stances require. Throughout the whole process of extraction, the mashing machine is used but once, and then from twenty minutes to half-an-hour the first mash. Again: I expect that the dubious exclamation will escape the lips of some when they read the assertion, of turning over boiling hot water upon the goods, as a fly mash for porter, who have been taught to believe that 180deg. for the second mash is as high as can safely or advantageously be administered.

But as such has been my practice for several years, both for ale and porter; and as I have really, or imaginarily, found a resulting advantage, I can only give it as a fact, and leave those who read it, to prove it or not, as they may think proper. To furnish theoretical arguments in support of the propriety of such a system of extraction, would, I think, prove useless, because inconclusive, inasmuch as I could only offer opinions, unaccompanied by indubitable proof of their correctness, and therefore I shall content myself by stating, that after brewing upon a varied system, for many years, I have found this (the last adopted, and still continued) the best, and by means of which, I conceive, I have been enabled to realise the proverbial conclusion, "that his system is best who can brew good beer in every season of the year, at the least cost."

For the brewing of porter, strong hops, and plenty of them, are requisite. But to prescribe an exact quantity that should be used, would be folly, as a variety of circumstances may require the use of a varied quantity. In the brewing of porter, I avail myself of the advantages afforded by the use of the hop table (which have furnished in the chapter entitled "Hops,") as well as for ale. The quantity I have used varies from 1¼ ounces to 2½ ounces of Sussex hops to 1lb. density of extract contained in the raw wort in the copper; and as I have already explained the method

of consulting such table, it will be useless here to repeat it. But upon this head, I conceive it necessary to suggest, that in determining the proper quantity, the brewer should be governed by the taste of his customers, the time the porter will probably remain unconsumed, the state of the weather, and the quality of the hops, whether weak or strong, old or new.

Porter worts require less boiling than ale worts, as relates to the necessity of coagulating the mucilage by boiling, because porter malt yields a much less quantity of it by solution. But as economy requires the obtainment of as much extract as can be obtained from the hops, without injuring the flavor of the wort; and as porter wort will bear a larger portion of the terrene bitter of the hop, extractible by long boiling, than ale wort will, without such an injury, I usually boil the porter worts about the same length of time as ale worts; for particulars of which see the ninth chapter on "Boiling of Worts."

In dividing the porter worts, I am governed by the requirements of trade. For double stout I appropriate the first, or the first and second boiled worts, getting them into the tun at the required strength. The remainder of the boiled wort, be its quantity and strength what it may, is let down into a separate tun, and is ultimately used for the purpose of reducing the double stout into single stout, by admixture, and in quantity proportionate to its strength, which is ascertained by calculation.

In pitching the tuns, my maxim is, a low heat (from 60 to 66 deg.), and small quantity of yeast (from two to five tenths of an ounce per pound density of extract of malt), varying both as the temperature of the atmosphere may dictate; and my object is to carry the fermentation to a proportionate point of attenuation, to its original density, so as to leave its materials and

capabilities, at the termination of the first and foul fermentation, equal to the production of a suitable quantity of carbonic acid in the second, or transparent fermentation, and possessing a desirable fulness to the palate. Thus, a wort of 26lbs. I should endeavour to attenuate to 10 or 12lbs., and not lower; and worts of any other density in the same proportion.

To brew good porter, as well as ale, nothing more than good malt, hops, yeast, and water, is necessary; and the addition of any other ingredient from the commencement of the brewing, to the moment of sending out (except isinglass for fining), is not only useless and unnecessary, but positively injurious, as well as illegal. Yet good materials, without a good system of brewing, and well attended to, will prove but of little avail in the production of good porter or ale.

I might swell this chapter to a much greater length, by a repetition of much which has been already furnished in the preceding pages, but as they apply equally to porter as to ale, it would be but a waste of time to repeat them.

CHAP. XVI.

TABLE BEER.

An attention to the brewing of table beer upon the best principles, is considered by many brewers as unimportant, or unworthy their attention.

To many it may be a matter of much more consequence than to others, resulting from a difference in their trade, or their system of brewing for it.

Since the prohibitive restrictions to the mixing of table beer with strong, for the purpose of sending out beer at any price, have been removed, the brewing of good table beer has become an indispensably necessary measure to ensure the commendation of the consumers, either in a separate or mixed state.

In many breweries it is most convenient to brew only ale of the greatest strength required for consumption, and by an admixture of table beer therewith, to make up ale of any lesser strength, or what is termed table ale. In such case, if the ale, by care and attention, is good, and by carelessness or inattention the table beer is bad, it is not only the latter which will give dissatisfaction, but beer of every price made up by admixture also. And to those who purposely brew ale of different strengths, for different prices, it is desirable that the lowest of their productions should prove satisfactory.

It cannot be supposed that the latter extracts from malt can be equal in quality to the first, the more so if improperly obtained, as is the case when effected by

mashing with hot or cold water, instead of sparging; consequently the appropriation of such for table beer cannot furnish so good an article as the entire product of fresh malt.

When the appropriation of the latter extracts after the brewing of ale, without any succeeding brewing of ale to follow, becomes a question of consideration, it is best to carry over such extracts in the form of a return wort to fresh malt for the brewing of table beer, rather than boil it, as it is for such a purpose, provided the brewer's consumption for table beer, with or without admixture, is sufficient to enable him, with propriety, to increase the quantity; but if not, he had better let the wort composed of such extracts be of less density when boiled than the strength of the lowest priced table beer he may have occasion to send out, as by the admixture of a portion of ale with it, to bring up its strength to the required standard, he may improve its quality by the addition of a portion of the first extracts of the malt.

The latter extracts from malt, comprising little or no saccharum, will not ferment so well as a wort the product of malt mashed with water, or return wort; consequently, the table beer made up of the former, even with the addition of ale, is not equal in quality to the latter without it.

In brewing table beer from fresh malt, and mashing with a return wort, it is often necessary to mash with a much larger quantity than would be the case if mashing with water, and in such case, the mashing tables will be found highly useful, exhibiting the varied heats which should be taken from the lowest quantity to the highest furnished—five barrels.

In brewing for table, I find the system of making a a fly mash and sparging, as for ale, attended with the same advantages.

When occasion requires the carrying over a return wort for mashing for table beer, and it is found that the raw wort in the copper is too strong for the intended purpose, after all the soluble extract is obtained from the malt, it is not well to add cold water, but hot, to the wort in the copper, to reduce it to the required strength; and if hot water cannot, for want of mechanical convenience, be got into the copper so conveniently as running it over the goods, and pumping it up from the under back, there can be no disadvantage arise, and the method will be found much better than using cold water.

The quantity of hops that should be used is so variable, that every brewer must be governed by his own judgment.

The fermentation of table beer requires strict attention, judgment, and care; for possessing more gluten than ale, it is liable to a lower attenuation; and as table beer at best is but thin drink, it need not be made unnecessarily thin by a low attenuation.

It may be safely set down as a maxim, that the lower the attenuation of ale or table beer, by the first and foul fermentation, that it becomes transparent by natural or artificial means, with less facility than when it occurs to a medium point; and that both will drink thin in proportion to the extent it is carried; yet the farther the distance, the greater is the quantity of spirit produced. The brewer has therefore to choose between the gratification of the palate and the stupefaction of the brain; and I think his devoirs to the former, will generally be found more profitable than to the latter, particularly as relates to table beer.

To prevent an attenuation of table beer beyond a desirable point, the same objections apply to mechanical or any other than natural means, as to ale or porter. A low pitching heat, with the smallest quan-

tity of good yeast, and early cleansing, with rousing before cleansing in winter, and without in summer, is the best method I have been able to discover; but no definite heat or quantity of yeast can properly be prescribed, as both should be as variable as the temperature and state of the atmosphere, as relates to the presence of oxygen. For the last year my pitching heats have varied from 64deg. to 70deg., and the quantity of yeast from 2½ tenths of an ounce to one ounce, for every pound density of extract contained in the wort.

The observations relative to overboiling already furnished, apply with double force to table beer.

To boil a table beer wort obtained from fresh malt, mashed either with or without return wort, two hours is quite sufficient; but, I think, that if the latter extracts, after a brewing of ale, are appropriated as a wort for table beer, that three hours boiling will be found better than two; but in such case, the hops should not be put into the copper until the wort has boiled one or one and a half hour.

CHAP. XVII.

EXPEDITIOUS AND ECONOMICAL METHOD OF BREWING.

That many valuable improvements in the system of brewing has been adopted within the last century, is unquestionably correct; but that few mechanical improvements in the apparatus for brewing have been generally made, is also indubitably true. Almost every new brewery which is built, and fitted up, is but a copy of some one already built, with an imitation of many of the ancient inconsistencies, and a large superfluous outlay of capital, to perpetuate an erroneous system of brewing.

Many are imbued with strong prejudices in favor of what they call "the good old-fashioned way of brewing," and spurn and laugh at the idea of a scientific system. Others there are who are too timid to consent to venture on an untried system in the way of experiment, or to run the least risk of a failure, for the sake of a probable advantage, and go on all their days, wishing for more knowledge, but are afraid to grasp it. And a few there are who have introduced mechanical improvements into the brewery, without duly considering, or being capable of judging, of the chemical consequences; and by failing to acquire an expected advantage, have been guilty of the mischief of propagating prejudice in the minds of many, where it did not previously exist; and confirming more strongly the in-

veterate prejudices of those who would never hear of innovation in the least degree.

I would ask many an unfortunate speculator, who has built and fitted up a brewery on a more extensive scale than his capital would admit, whether if he had been informed that an outlay of one-fourth the amount, would have furnished him with all that he stood in need of for the purposes of trade, and thereby leaving three-fourths for the advantageous conducting of it, whether he would not have hailed the information with pleasure? And I would again ask many who have built and fitted up on erroneous principles, and who have had sufficient, and more than sufficient capital for the purpose, whether, if they could have been convinced, that an outlay of one-fourth the amount would have sufficed, they would not also gladly have availed themselves of the opportunity of effecting it, whereby they would not only have saved the interest upon the superfluous expenditure, but also a large annual amount in taxes, repairs, and incidental expenses?

But what can be the utility of such questions to such persons, some well may say, after the mischief is done? Certainly none! Unless fortuitous circumstances may have placed them in the situation to renew their endeavours to perform successfully that which they before did imprudently, or for want of knowledge, or to warn the young and inexperienced against the evil of treading in their steps, and to enable them to point to a more safe and certain way to effect their purpose with as small a capital as is possible. And it is such persons, who have thus erred, to whom I now address these preliminary questions, who will be best able, probably, to appreciate the value of the system I am now about to communicate, because having smarted for want of knowing it, they may be the better able to discern its advantages.

In order to elucidate the system of brewing with despatch and economy, I have furnished a sketch (as will be seen by an inspection of Plate 2nd.) of the fittings-up of a brewery, with a double set of utensils, omitting such parts as are not necessary for the purpose of illustration, and which would give a complexity of appearance to the whole, that might be calculated to defeat rather than to facilitate explanation, and I will endeavour to supply the deficiency by written details.

It will be quite evident, I trust, to the reflecting reader, that the position and arrangement of the utensils, as shown, are for the purpose merely of exhibiting the principle in a convenient form, in order that at one view, the mind may comprehend with facility the simplicity and advantage of the arrangement, and what deviation may be consistently made therefrom (without losing sight of the principle), to suit existing or intended premises. And it will be equally plain, that a single set of utensils may be fitted up instead of a double.

A. Is intended to describe the whole malt bin.

B. The situation of the crushing rollers, or grinding stones.

C.C. Two ground malt bins.

D.D. The cold liquor compartments of two liquor backs.

E.E. A wooden or metal open cylinder to each liquor back, placed in the centre, or near the side of access, affixed to the internal head, or partition that divides the cold liquor compartment (D), from the hot liquor compartment (F), and serves for the double purpose, of a way of access to the hot liquor compartment, for cleansing, repairs, &c., and for ascertaining the heat of the liquor therein, for mashing, &c.

F.F. The hot liquor compartments of the liquor backs.

G.G. The supports of the two liquor backs.

H.H. Two mash tuns.
I.I. Two boilers.
J.J. Furnaces.
K.K. Ash pits.
L.L. Two fermenting tuns.
M.M. Fermenting casks.
R. Stillion or stollage.

PROCESS OF BREWING.

The boilers (I I), (be their shape what they may) are furnished with man-holes, which shut steam tight, and serve for the double purpose of steam boilers, and boilers in which to boil the wort; and are fitted up with the necessary valves, pipes, and cocks.

A steam-pipe from each (which should be covered with some non-conducting heat substance, such as cloth, &c.), conveys steam from boiling water or wort, into the hot liquor compartments (F F) of the liquor back, for the purpose of raising the temperature of the water or return wort therein to any required heat, for mashing, &c. Such steam pipes are fixed into the crowns of the boilers, and rise as high as the tops of the liquor backs, then bend (and at the top of such bend is affixed a valve that falls inward), and continue their course downward, and enter into the side of the liquor back near the bottom of the hot liquor compartment, and take a circular sweep within; such part of the pipe as is within, being pierced its whole length with a number of small holes, through which the steam is transmitted, without noise or violent concussion, to the water within.

The water, or return wort, being heated by steam to the required temperature for mashing, a sufficient quantity is conveyed from the hot liquor compartment (F) into the mash-tun, by a pipe connecting the bottoms of each, or by a cock in the side of the liquor

back, communicating with a trunk affixed to the side of the mash-tun within, or in any way, as it is usual to be conveyed thereto from the copper.

The mashing process performed, and a sufficient time elapsed previous to the setting of the taps, they are opened in the usual manner, and the wort is at once conveyed into the boiler, the water therein having been previously withdrawn. As soon as the taps are set, and the bottom of the boiler is covered with wort, the fire may be gradually raised, increasing in intensity, so as to raise the wort to the boiling point by the time it is all down, yet without burning the copper.

By this method, instead of allowing the wort first to run all down into an under back, and then to pump it up into the copper, it must be sufficiently evident to the experienced brewer, that much time, labour, and fuel, is saved, and which saving occurs upon every wort.

As soon as the first wort is in the boiler, the mash-tun spending taps are shut, and the water, or remainder of the return wort, in the hot liquor compartment of the liquor back, which was raised to boiling heat by steam from the boiler during the time the first mashing was effected, and while the wort was on the goods, is either turned over the goods in a fly mash, or by sparging. The second boiler will now be found extremely useful, as the raw wort to constitute the second boiled wort may be conveyed to it, as soon as it can consistently be run from the goods, and may be brought to a boiling state, as was the first wort. The steam from each boiling wort will be found more than sufficient for the purpose of heating water for sparging, and the superfluous quantity may be conveyed to the cylinder of the steam engine. The two boilers will also furnish a sufficient quantity of steam, either from water or wort, to heat all the liquor required for mashing, sparging and scalding, and as a motive power to

the machinery for grinding, pumping, &c. As relates to the remainder of the process, the mind will easily conceive the course to be pursued, from what has been already stated, and will be found in the succeeding pages.

To contrast the old and new System, by detailing the process under each head, in its various stages, in juxta position, appears to me to be the best calculated to exhibit the defects of the former, and the superiority of the latter.

THE OLD SYSTEM.

The first mashing heat taken by guess; and by many to the same degree all the year through, regardless of seasons and circumstances, and by none with accuracy.

The process of mashing by manual labour or machinery, performed for one hour the first mash, under the erroneous idea that much stirring facilitates and promotes solution, without reflecting that thereby the most important agent in extraction (heat) is lost; which method may appropriately be termed "the grasping at the shadow and losing the substance."

Setting the taps, to run off the first wort, from the goods at the end of one hour, or a longer period, after the process of mashing is finished, whereby the heat of the wort and goods is diminished unnecessarily and disadvantageously, causing a waste of time and fuel to raise the former to the temperature at which it would have been had the taps been set earlier, (in hot weather particularly) and exposing it to the certainty of absorbing oxygen to an injurious extent from the

THE NEW SYSTEM.

The first mashing heat taken by rule, subject to arithmetical calculation, upon the data of the weight and heat of the malt, and the quantity of the malt, and the quantity of liquor mashed with, with tables to refer to, to save the practitioner the trouble of calculating for every brewing.

The process of mashing by manual labour or machinery, performed as expeditiously as possible, and not continued a minute longer than is necessary to cause the whole of the malt to be well divided and mixed with the mashing menstruum, which may be generally effected in from ten to twenty minutes. The purport of which is to prevent any absolutely unnecessary loss of heat, (for which purpose also the process ought to be done under cover), and because of the conviction, that agitation, in the case of malt, rather impedes than promotes solution.

Setting the taps to run off the first wort from the goods, at the end of half or three quarters of an hour, from the time the mashing process terminates, furnishes as strong an extract as if allowed to remain a longer period on the goods, and by having a sufficient number of taps, each set to run off a small stream at the commencement, the wort may be run off as clear, and more expeditiously, than with a single tap at a great speed. By such a method time and fuel is saved,

atmosphere; and also by allowing the goods to lose a portion of their heat, beyond the limits of necessity, the extractive powers of the second liquor, is considerably decreased.

The first and subsequent worts run from the mash tun into the under back, where it remains generally until the whole is off, and sometimes longer, and is then pumped into the copper. The consequences are, that much heat, time, and fuel is lost, absorption of oxygen occurs, and labour and wear and tear of machinery is occasioned; loss of extract by adhesion to the surface of a superfluous vessel ensues, and the room which such vessel occupies, its first cost, its wear and tear, &c. &c., may be dispensed with.

The second mashing liquor is turned under the goods by some, and over by others, at a temperature varying from 160 to 190 deg., and sufficient in quantity to constitute a second boiled wort; and the process of mashing is renewed, for a variable period; and after mashing, the wort is allowed to remain a considerable period on the goods, for the purpose of settling and becoming fine, and in expectation of the obtainment of a wort of greater strength thereby.

The disadvantages of such a process are, that a large quantity of gluten is dissolved, which is not needed. Labour and time is lost, the soluble extract of the malt is diffused through a larger quantity of water than can act as an extracting menstruum, a great portion of it never coming in contact with the malt, consequently a weak and inferior wort is the result. But such a mode of mashing may be more aptly and intelligibly illustrated by comparing it with the infusing of tea in the tea-pot, with water that does not boil, and too much of it.

charring the wort is prevented, and the goods are left at a proper heat, to receive the second liquor; whereby the second and all subsequent extracts are greater in strength, better in quality, and of higher temperature, saving time and fuel throughout the whole process.

The first and subsequent worts run from the mash tun into one of the coppers which are placed below it, and instead of diminishing, are constantly increasing in heat, while running down, by a gradual increase of the action of the fire in the furnace, so that by the time the whole of the wort is down, they may boil. By this method the objectionable particulars, stated as occurring by the old system, may be avoided, and the benefits accruing from despatch ensured.

The second liquor is turned over the goods as a fly mash, and is so termed because the liquor is allowed to run upon a splash board, placed above the goods, and as near the centre of the mash tun as conveniently can be; whereby it is distributed over the surface of the goods without disturbing them. Such liquor is turned over boiling hot, and in quantity from one-half to two-thirds of what is required to constitute the second boiled wort, and the residue which is needed is obtained by sparging. The advantages of this method are, that the goods having been mashed the first time, with liquor at a proper temperature, no fear of setting them by a subsequent liquor, at the highest obtainable temperature, need be apprehended, and boiling liquor will ensure a better and greater extract than liquor at any lower heat, and also raise the goods in heat, whereby a better extractive power is secured throughout the subsequent process of sparging with liquor at a lower temperature. Time and fuel is also saved. A larger quantity of malt extract is also obtained in a much

The third mash is made with liquor obtained from the pan of the dome copper, or from the copper itself, where a dome copper is not used, at a temperature from 160 tu 190deg., as suits the views or capabilities of different brewers, &c., provided the third wort is intended for a weak ale, or table beer; but in case it is intended for a return wort, many mash or sprinkle with cold liquor.

The disadvantages are, that where a dome copper is

smaller quantity of wort, whereby boiling to reduce quantity, to obtain a required strength, is rendered unnecessary, and all the consequent loss of time, fuel, and injury to quality of worts is prevented.

By a fly mash (say 15 barrels of liquor to 20 quarters of malt) turned over the goods with rapidity, in the manner stated, they become considerably compressed by the weight of the liquor turned over, before it has time to penetrate through them; consequently, the percolation of the mashing liquor is beneficially retarded, and in its downward progress through the goods, it has time to dissolve the soluble material of the malt, and to become enriched from every particle of malt it comes in contact with, and each succeeding particle of liquor takes up a portion of extract, which the preceding one had left behind. And these observations equally apply to the process of sparging; and each drop that descends from the sprinkling machine may be compared, in its progress from one particle of malt to another, deriving extract from each, to the single bee, that ranges from flower to flower, sipping those sweets from each, which vegetation is continually presenting, instead of the conjunctive efforts of several in company, to obtain from one flower, the surface of which a single visitant may cover.

The sparging process is continued for the third, or occasionally a fourth wort, which method enables the obtainment of a better and stronger extract, with a less quantity of liquor than can be obtained by the system of mashing.

Sparging may be continued until the wort comes down milky, and should then be discontinued; but such will not occur if the sparging liquor is hot, until the density of the wort comes down at from 1½ to 3 pounds.

not used, and only one open copper, the third mashing liquor must be heated in the copper in which the worts are boiled, between the boiling of the first and second worts; the consequence is, that while such is effecting, the second wort is lying in the under back, absorbing oxygen, and losing its heat; and much time is lost. But with a dome copper, the third liquor for mashing is heated in the pan, by the steam from the first wort which is boiling in the copper beneath; therefore the dome copper furnishes the means of saving fuel and time, and prevents the injury sustained by the absorption of so much oxygen.

All the disadvantages which have already been enumerated as resulting from a second mashing, and with a large quantity of liquor, apply to a third process. And the idle, or parsimonious motive, to mash with cold liquor for a return wort, is met with a weak and glutenous extract, proving both unprofitable and injurious, and unfit to be carried over to fresh malt, as a mashing menstruum for strong ale.

Each successive wort is, when sufficiently boiled, run off from the copper into the hop back, and from thence into cooling backs, where it is allowed to lay until sufficiently cool to let down into the fermenting tun, provided the temperature of the atmosphere will admit of its being reduced by its influence to a right heat. But in warm weather, when the wort requires to be pitched at a lower heat than in cold, it is impossible to get the wort into the tun at so low a heat in the day-time as it ought to be, and the night-air is often chosen as the cooling medium; but even such, in sultry weather, is not sufficiently cool for the purpose. At such a period it is no uncommon occurrence, to require from 20 to 28 hours to complete a brewing, from the time of first mashing until the whole of the worts are in the tun.

THE NEW SYSTEM.

The liquor for sparging is made hot, in the hot liquor back, by steam from the first and second boiled worts.

While the first wort is boiling in one copper, the second wort is running from the mash tun into the other copper, and which is brought to boil by the time, or before, the required quantity of wort is down.

As soon as the first boiled wort is run off into the hop back, the third wort runs from the mash tun into the first copper; and in case a fourth wort should be made, it will be run off into the second copper, as soon as the second boiled wort is off.

If it is intended to brew a second brewing immediately after the first, (or rather before the first is finished), the grains should be taken out of the mash tun, while the third or fourth wort is boiling, and recharged with malt, and the mashing liquor brought to a right heat by the steam from the boiling wort, and as soon as ready, the second brewing may commence.

Each successive wort is, when sufficiently boiled, run off from the copper into the hop back, and from thence into one or more cooling backs, in which it should not lay any longer than possible in hot weather. From thence, (or if preferred immediately from the hop back), it passes through the refrigerator into the fermenting tuns, and is reduced in temperature as low as 58deg., if required, (or any other point above as may be deemed best); in the hottest of weather the cooling medium being water, pumped immediately from the well, through the refrigerator into the liquor back. The advantages of this method are, despatch, prevention of an absorption of oxygen to an injurious extent, the capability of pitching the tun at a right temperature, and controlling the fermentation within the limits of suitability.

And the resulting evils often are, an acetified wort, pitched at a high temperature, and subject to a violent fermentation.

Having asserted "That by the new system, a brewing of from four quarters of malt up to thirty, may be begun and finished, from the time of first mashing until the whole of the worts are in the tuns, within the period of from six to eight hours; or, double brewings in from ten and a half to fourteen hours and a half:" it becomes necessary that I should furnish such details, as will evince its practicability; and conceiving that one statement relative to the brewing of 30qrs. of malt, will suffice to establish the correctness of the assertion as regards the rest, I therefore refrain from furnishing additional details.

On comparing the following suppositious statement, with the statement of an actual brewing of 26qrs. of malt, (given in pages 122 & 123), performed upon the old system, some apparent discrepancies may be perceived, which require some explanation to prevent the inculcation of a doubt as to their accuracy.

In the first statement it will be seen, that from the time the spending taps were set to run off the first wort, until the whole of the wort was down in the under back, a period of seventy-two minutes occurred in running off thirty-two barrels; whereas, in the last statement,

THE NEW SYSTEM.

By pursuing this method, brewings of from 4qrs. up to 30qrs. may be finished, in from 6 to 8 hours from the time of first mashing, until the whole of the worts are in the tun, without any injury; but, on the contrary, a benefit to the quality of the beer. And in brewing two brewings, one following the other, (but the second begun before the first is finished), both may be accomplished in less than in double the time that would be sufficient to accomplish the two, separately.

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forty minutes is only allowed to run off forty-two barrels. To account for this discrepancy, it is necessary to state, that but three spending taps were inserted in the bottom of the mash tun, from which the thirty-two barrels ran, and that, in adopting the new system, I should recommend the insertion of six, which would run off the forty-two barrels in the time specified.

But the reader may imagine, that the shortening the time of mashing, and setting the taps so early after the mashing is finished, is quite enough without diminishing the time for running off the wort from the goods; and he may think that the necessary consequence would be —the product of a weaker wort: but the best reply to such a supposition will be found in the following statement of the heat and density of the first wort of thirty-five barrels from twenty-six quarters of malt, as per sample, taken every five minutes during the time it ran from the mash tun into the under back.

The mashing process was finished at 7 o'clock, and the three spending taps set at 8 o'clock.

Time.		deg.		lbs.	ths.
M 8 5	heat of wort.	139	density.	36	0
8 10		144		36	0
8 15		145		35	1
8 20		146		35	0

Time.		deg.		lbs.	ths.
8 25	heat of Wort.	146	density.	35	0
8 30		144		34	7
8 35		144		34	6
8 40		145		34	9
8 45		145		35	1
8 50		144		35	4
8 55		144		35	4
9 0		140		34	6
9 5		140		35	7

From the above statement, I trust it will appear quite evident, that if the whole of the wort could have been got off in five minutes instead of 65, the density of the whole would have been equally great, and I am quite satisfied equally as fine, provided a sufficient number of spending taps were used.

It will also appear from the statement, exhibiting the prompt process of brewing, that I have allowed but fifteen minutes for sparging on, and running off, a much larger quantity than detailed in pages 122 & 123; and it becomes necessary to state, that, in the brewing there referred to, the sparging process was purposely lengthened out, with a view to get the last sparge off a short time before the second wort was sufficiently boiled, in order to keep the wort in the under back in a continual state of agitation, until able to convey it into the copper, experience teaching that in such state it was less liable to the absorption of oxygen from the atmosphere.

By reference to such brewing it will be seen that the sparging process was not finished until E5 20. And in a brewing of to day (Aug. 11th, 1835), of 26qrs. of malt, began at the same time as the brewing referred to in pages 122& 123, I caused the sparging process to be continued without intermission for the third wort, until the last wort came off at a density of 3lbs. 2ths., the hot liquor being constantly sprinkled over the goods and the spending taps open until finished, which was effected at E 2 30, and the usual density obtained, in the usual quantity of wort.

TIME. h. m.	Statement of the details of a brewing of 30qrs. of Malt, in eight hours from the time of adjusting the liquor to a right heat for mashing, until the pitching of the tun, or the termination of the brewing.
M 6 30	Reduced liquor in hot liquor back from 212 to 179 deg. for mashing.
6 40	Turned on 64bls. of liquor under the goods.
6 50	Liquor all down in mash tun.
7 13	Mashing finished.
8 13	Set spending taps to run off the first wort from the mash tun into boiler.
8 53	Frst wort all down from mash tun into boiler 42bls
9 0	Turned over goods (as fly mash) 28bs. boiling liqr.
9 5	Hops in boiler, and worts boiling.
9 20	Set the spending taps, to run off wort of fly mash.
9 50	Wort from fly mash, all down in second boiler.
9 50	Commenced the first sparge.
10 5	7 barrels of wort of first sparge in second boiler.
10 20	6 do. of do. of second ditto
10 35	6 do. of do. of third ditto
10 35	The first wort struck, having boiled 1½ hour.
10 40	The second wort boiling, & hops in boiler, 47bls.
10 55	6 barrels of wort of fourth sparge, in first boiler.
11 10	6 do. of do. of fifth ditto
11 15	Commenced cooling the first wort.
11 25	5 barrels of wort, seventh sparge, in first boiler.
11 40	6 do. of do. of eighth ditto
11 55	6 do. of do. of ninth ditto
E 12 7	5 do. of do. of tenth ditto
12 20	5 do. of do. of eleventh ditto
12 30	4 do. of do. of twelfth ditto
12 30	The first boiled wort, all in fermenting tun.
12 35	The third wort boiling.
12 40	The second wort struck, having boiled two hours
12 40	Turned the third wort over hops in hop back.
12 45	Commenced pumping up the third wort from hop back into hot liquor compartment of liquor back.
1 0	Commenced cooling the second boiled wort.
1 0	Third wort all pumped up, and sufficiently hot for mashing malt of the second brewing.
2 30	The second boiled wort in the fermenting tun, yeast added, and brewing finished.

In the preceding statement it appears that I have represented the return wort as ready for the first mash of the second brewing at one o'clock, and on the supposition that the second mash tun, has been previously charged with malt, (or the malt is ready in the bin to

add to the mashing menstruum, in case such method is practised), the second brewing may commence at one o'clock. and occupying eight hours as the first, may be finished at nine o'clock, making fourteen hours and a half occupied in getting through the two brewings.

Here the reader may probably say—Why not brew the full quantity of malt at one brewing, instead of two, and save the double labour and loss of time, &c.? And he might further ask—Would the single apparatus, to brew the full quantity at once, cost more than the double apparatus to brew it at twice? To such questions, if asked, my reply is—that if a brewer's trade was so regular all the year through, that he should brew any definite quantity of malt, per day, for five days in the week leaving one clear day for cleaning up, &c., then by all means he should have the single apparatus; but if, on the contrary, his trade is irregular, and at one time he may have occasion to brew the full quantity, and at another time but half or any intermediate quantity, then I think he should have the double apparatus, because he will find it more advantageous to brew in utensils of the proper size, than in such as are twice as large as is required, or of any intermediate dimensions.

But there are few brewers whose trade is regular, and many have occasion to brew much more at one period than another; and I am decidedly of opinion, that as relates to capital, to current expences, and to quality of the beer, it is better that the builder of a new brewery should, in estimating his probable consumption of malt per week in brewing, at the dullest period, divide the total by five days at single brewings, and build and fit up his brewery on such a proportionate scale, reserving the means of brewing twice per day, with a single or double apparatus, as his means would enable, in case of an uncertain or certain requirement in the most busy season.

Let us suppose, that a person possessed of ample capital, is determined to build and fit up a brewery, in which he can brew 50 quarters of malt per week. Now he might build and fit up on such a scale as to effect it at one operation. Or he might brew it at twice, or in five or six brewings, upon the old system; but upon the new system he might do it in less time in ten brewings, five quarters at a time. Now the difference in the cost of a five quarter brewery and a fifty must obviously be very great, the rental or interest upon the outlay, the taxes, the repairs, the number of men employed, must also be very disproportionate. Thus, as far as the outlay of capital, and the amount of expenses of conducting the business applies, the advantage would be decidedly in favor of the small brewery, even if the brewer's expectation of being able to find sale for the produce of fifty quarters should be realised; but if not, and perhaps not more than half the quantity could be disposed of, he would find it most evidently correct that the small scale would prove far more profitable than the large.

Such brewers as are brewing in breweries fitted up upon the old principle, I should not advise to have recourse to the new, unless they find their present apparatus inadequate to the manufacture of a sufficient quantity of beer, or unless the occupation of so much time and labour by the old method was a serious inconvenience to them. But if enlargement, or a new copper, was necessary, then I should strongly recommend its adoption, and am satisfied that the saving in fuel, time and labour, would very soon repay the cost of the necessary alterations.

I will now close this chapter by informing the reader, that more than four years ago I furnished a plan for the building and fitting up a four-quarter brewery, the total cost of which was under £500. It was fitted

up on the principles herein referred to, with a single apparatus for brewing, and the parties holding it, I am informed, are brewing from 8 to 12 qrs. per week. The length of the building is 22 feet, and the breadth 14 feet. The basement is a cellar, about 12 feet depth, used as the cleansing room, and in which is placed two fermenting tuns, opening into the room above. The first floor comprises, a small counting room, about 6 feet by 8, (I speak from memory only), the brewing copper, the hop back, and the refrigerator; the water pump, worked by hand; a staircase leading down into the cleansing room, and another leading into the room above: the pitch of this room is about 10 feet. The second floor comprises the mash tun, the hot and cold liquor back, a hand steel malt mill, a hoisting tackle, and a malt and hop store. Beneath an adjoining house, and connected by a doorway with the cleansing room, is a small store cellar. Thus, at a very moderate rental and taxation, and at small current expenses, can the brewing of these 8 or 12 qrs. of malt per week be effected, and if required, a larger quantity on the same premises might be brewed with facility.

CHAP. XVIII.

SEASONING NEW UTENSILS AND CASKS, AND ABSTRACTING, FROM OLD, EVERY IMPURITY.

All knowledge which is conducive to the welfare of a person's trade, must be valuable to its possessor, in proportion to the benefit derived, and nothing relative is unworthy of the efforts of industry to obtain it.

In the brewery, the seasoning of new utensils and casks, and the sweetening of old, is both an important and extensive operation; and to avoid the effect of an impartation of an ill flavor to beer, it should be effectually and carefully performed.

A person commencing business in a new brewery, with new utensils and new casks, is placed in a very dangerous and critical situation, and at a momentous period. He has to brew and send out his beer in wood which will impart an ill flavor to it, in case the substance which effects it is not previously eradicated therefrom; and if it is eradicated, the wood will rob his beer of spirit and carbonic acid, until well impregnated with both, and not till then can it be deemed well seasoned. At first starting he naturally feels very anxious to furnish good beer, and thereby to make a good impression on the public mind. The public expect much from a new brewer, and generally the best beer at the first delivery. If the brewer has not taken his measures right, both parties are disappointed. The

one is vexed, and the other prejudiced. Much of the first sent out may be returned, and he becomes fettered with an injurious stock at the outset, with which he subsequently spoils much more by admixture, in his haste and anxiety to get rid of it.

The first steps to the removal of an evil, are, a knowledge of its existence, its nature, properties, and capabilities; and the second, the several means to remove it, and an industrious and careful application of them.

The principle in oak wood, which imparts an ill flavor to fluids which extract it, is tannin; and in fir, tannin and turpentine. There are several methods by which it may be extracted.

By steam! but the objection to this method is, that the power which is equal to the extraction, is equal to the serious injury of the wood; for it does not act chemically upon the tannin, &c., but mechanically. It penetrates the inmost recesses of the wood, and expels the tannin by mechanical force, and to a greater extent than is needed, because its powers cannot be controlled. To properly season a cask, without seriously injuring the wood, the tannin should be extracted from the interior surface of the cask, only as deep as the beer can ever penetrate, and then the remainder of the wood is unimpaired; but if you give access to steam within a cask, you cannot say to it go thus far, and no farther. Once admitted, the way of exit to the heat, (which forms the largest component part of steam) is through the pores of the wood, and the water in combination washes out the tannin to the very core.

By lime! The objection to this method is, that it is not sufficiently powerful to destroy the tannin, even on the interior surface of the cask, over which it may be spread in the state of lime wash; and that, as in that or any other state alone, it will not penetrate and abstract from the interior of the wood, the tannin, &c. it is unfit to accomplish the object.

By hot and cold water! The objection to either may not be valid as relates to capability to accomplish it. but as to the time and frequent changes that might be required by its use.

By fire! The objection to this, is the injury done to the wood, and the mere exchange of one ill flavor for another, as well the liability to affect the color and transparency of the beer.

By lees! I know of no other objection to its use than the expense and trouble of boiling, and of making. But as no advantage can be obtained without some countervailing disadvantages, and as neither one or the other are great, they are points not worth consideration. I have adopted the use of lees for seasoning new wood and purifying old, and have ever found it completely effectual for both purposes. To make it:— The best description of vessel for the purpose would be one of suitable shape, of cast iron, with a tap hole in the side near the bottom, in which should be placed a trunk pierced full of small holes, enclosing the tap hole, and affixed to the side of the vessel, reaching from the bottom to the top, and which should be covered over on the outside with reeds, straw, or broom heath, or any suitable substance, to prevent the holes from being filled up, and through which the lees may percolate and be drawn off from the tap hole.

The vessel being prepared, take a sufficient quantity of wood-ashes and lime, (in the ratio of four bushels of wood-ashes to one bushel of fresh dried grey lime) as will about half fill the vessel. Lay the wood-ashes on a clean paved floor in a circle (as is sand in the making of mortar), and put the lime in the middle, and cover it with a thin layer of the ashes, and let it thus remain until the lime is dry slacked, and become pulverulent. Then with a shovel mix the whole well together, and put it dry in the vessel, and fill up the same with water.

Let it stand two or three days, and it will be fit for use. For the seasoning of casks, and many other purposes, it may be used, and returned again into the vessel, upon the lime and ashes, by passing through which it will be purified, gain fresh strength, and be again fit for use; and the addition of a little more water may occasionally be made. This process may be continued until the strength of the lees is so far reduced, as to render them inadequate to fulfil the purpose for which they are required. When such is the case, they should be drawn from the vessel, the spent lime and ashes taken out, a fresh quantity put in, and the weak lees poured over, and water added, enough to fill the vessel.

The most effective state in which lees can be used, both for seasoning and sweetening, is in a boiling state. About two gallons to a nine gallon cask, (and other sizes in proportion) poured boiling hot into it, the cask bunged down, rolled about, and the lees allowed to remain in it about twelve hours, will be sufficient to season or sweeten it, provided the lees are strong. The cask should afterwards be filled with hot liquor, which should be allowed to remain so a few hours, and subsequently two or three times rinced with hot liquor.

CHAP. XIX.

PRESSING OF YEAST, FOR THE PURPOSE OF SEPARATING IT FROM THE WORT MIXED WITH IT.

"Take care of the pence, and let the pounds take care of themselves," is an adage, which it will not be amiss to remind the brewer of.

In too many breweries, much is wasted which might be saved, and although each item, separately viewed, may not appear as of much value, yet, when taken collectively, the amount may be great, and the importance of the saving may be proportionate both in the large and small brewery, and worth the labour bestowed to effect it in the course of the year.

Previous to the use of what is termed "patent yeast" by the bakers, brewer's yeast was in great demand, and a large annual amount was realized by its sale. But since the baker's have ceased to become permanent customers, yeast has become comparatively unprofitable to a large brewer, and much in the course of a year is usually thrown away, for which customers cannot be found at any price. To such brewers, then, the extraction of wort from yeast which he cannot sell, will prove advantageous in proportion to the quantity of yeast which he cannot sell. And, for the information of such, I am induced to furnish such particulars as they may need, if not acquainted with the method of extraction, &c. I will describe the process as pursued in the brewery in

which I am now engaged. The press employed is used for the double purpose of pressing hops in the pocket, and yeast, and the same press might be used also for the pressing of spent hops after brewing, but for the latter purpose we have a separate press. It is fitted up on common principles, as screw presses generally are.

The yeast is put into bags, made of swanskin flannel 18 inches long and 9 inches wide, and which are tied tight. A layer of these bags, lying side by side, is placed on a wooden false bottom pierced full of holes, standing up about an inch from the real bottom of a wooden box, the dimensions of which are two feet six inches square, and one foot nine inches deep, made of two inch deal, strongly united and water tight; a spout is inserted in the front side of this box, between the real and false bottoms, through which runs the wort pressed from the yeast into a receiver; upon this layer of bags is placed a flat board, pierced full of holes, fitting loosely within the box, and upon this board is placed another layer of bags, and upon this layer of bags is placed another flat board which is not pierced with holes; upon the last board another board—one and a half inch thick, is placed, to which is attached an upright, well braced, about one foot long, the end of which receiving the pressure of the screw, by medium of a transverse bar of wood attached to the screw, rising and falling with it, communicates the needful pressure to the bags, which pressure should be imparted slowly and gradually, not renewing the pressure until the wort has ceased to flow, lest the yeast should be also pressed through the bags, or that they should be burst. The wort obtained by this means will be found thick and yeast bitten, and in that state unfit for any beneficial use; and the next step is to get it fine, and as much as possible free it from such a flavor. For this purpose, as many chips from beech wood as is re-

requisite to fill a sufficient number of casks, should be obtained, and the tannin should bewell extracted therefrom by lees, which may best be effected by boiling them in lees in a copper. When done they should be well scalded, or they may be boiled in one or more changes of clean water, which would prove the most prompt and effectual way. Being well seasoned, they should be put into casks, which had best be loosely filled with them. The first cask should then be filled with the wort immediately from the press, and which should be allowed to remain therein for a few days. It should next be drawn off in a very slow and fine stream, and the second cask filled with it, and this operation should be repeated from cask to cask, until being drawn from the last, it should be put into an empty cask, and there remain until wanted, or found fit for use.

Each cask may receive several (say six) portions of wort thus transferred from one to the other, before they will require to be scalded out, which is done with the chips in, as an empty cask would be done.

The utility of the chips is to afford surface to promote depuration and adhesion of the yeast, &c. contained in the wort, and serve as a medium to ensure ultimate transparency, and freedom from the yeast bitten flavor.

If this process has been carefully and promptly attended to, without the wort having been allowed to acquire any acid during the operation, it may be broke into the tun at the time of pitching, and for such a purpose, absolute transparency and freedom from yeasty flavor is not requisite; but if on the contrary, the acquirement of acid is unavoidable, or by neglect has been suffered, then it may be reserved for finings, and used as soon as it becomes bright.

To satisfy the reader of the advantage resulting, as relates to the quantity of wort which may be extracted,

I will furnish the produce of a single experiment made to ascertain it.

From 472lbs. of yeast, obtained 26gals. of wort.

The bags should be washed and dried between every pressing.

To those who have a sale for the whole of their yeast, or the greatest part of it, the system may be worth pursuing, for after yeast has been pressed, the dry yeast taken out of the bags may be wet up with a little weak return wort to the proper consistence for sale, and it will be found less bitter, and equal to the same purposes as would be table beer yeast, which, for domestic use, is usually preferred to any other. Dry yeast, thus obtained, may be preserved by close and tight packing, if kept free from the access of air, and thereby provision may be made for a time of scarcity, during the time in which it may be abundant.

THE END.

Phillips and Co. Printers, 13, Poplar-place, Brighton.

ERRATA.

Page 140, line 22 -for 3lbs. 1oz. 5ths. ***read*** **3lbs. 3oz.**

Page 140, line 30--for 21lbs. 4oz. ***read*** **2lbs. 4oz.**

Page 152, line 21—for can be done ***read*** **cannot be done;**